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Fall Brook Division

Corning Glass Works

By Our Editorial Staff

BUILT in response to President Hoover's requests that industry proceed with new construction as a means of combating depression, the Fall Brook Division of Corning Glass Works at Corning, New York, has just been completed and put into operation. This plant, which was designed and built specifically for the manufacture of glass tubing and rod, is undoubtedly the last word in efficiency and modern construction.

The general layout and design of the buildings and equipment was carried out by the Engineering Department of Corning Glass Works. The general contract was awarded to the H. K. Ferguson Company of Cleveland, Ohio, and included the construction of all new buildings and changes to the one existing building used as a mixing house. Also included in this contract were power house equipment, fuel oil system, producer equipment and gas mains, steam lines, fire protection and underground lines. The contract for the coal handling equipment and all machinery in the mixing building was let to the Stephens-Adamson Manufacturing Company of Aurora, Ill. The tanks, tube reheaters, trough kilns, mandrel, oven and soot incinerators were designed and built by the engineering and construction forces of Corning Glass Works, who also installed all of the glass making machinery.

To provide for future expansion a plot of ground with a total area of about 21 acres and a frontage of 1,073 feet along Tioga Avenue was obtained. However, for present use only 6.3 acres or a plot 500 ft. x 550 ft. has been fenced in.

Two railroad sidings enter the property and run parallel to the street. One passes in front of the main building and is for shipments of completed ware. Four cars can be loaded at one time and by double tracking in the future, and loading through the cars, this number may be doubled. The other siding runs parallel to the rear of the building and will be used for incoming cars of boiler coal, power house coal, fuel oil and mixing materials.

Building sizes and areas are as follows:

Buildings:	Size	Area Sq. Ft.	
Main manufacturing and storage building:			
Ground floor	140 wide x 321 long	47,870	
Mezzanine or tank working floor	149 wide x 60 long	8,950	
Finishing mezzanine floor	149 wide x 140 long	20,875	
			77,695
Producer house, 2 floors, 16 x 16			512
Boiler house	30 x 44		1,320
Mixing building:			
1st floor	181.5′ x 44.33′	8,045	
Mezzanine	44.33 x 15.	670	
			8,715
Fuel Oil House	14.5 wide x 10.5 long	150	150
Total			88,392

Besides the above there is on the property a single story brick building with 24,000 sq. ft. area which will be used for miscellaneous storage.

The main building was so constructed that several advantages were gained over a building with all the operations on a single floor. When tube-runs are on one floor, the space between them is practically useless, as it is narrow and access to it can be had from one end only. Economically, space which cannot be utilized is not justified and so the building was designed with the tube-runs hung from the roof trusses as shown in the photograph. Sufficient head-room has been provided so that the space below, which is used for storage purposes, is free and unobstructed. This design also results in better ventilation in the tank house.

The arrangement of the building gives straight line production, maximum usable floor area, adequate storage facilities, good light and ventilation, and centralized control with a view of practically the entire plant from the office windows.

Provision is made for a third tank and two additional tube runs. The west side of the building is so designed that if it is desired to install additional tanks the entire side can be easily removed and the building extended westward. The

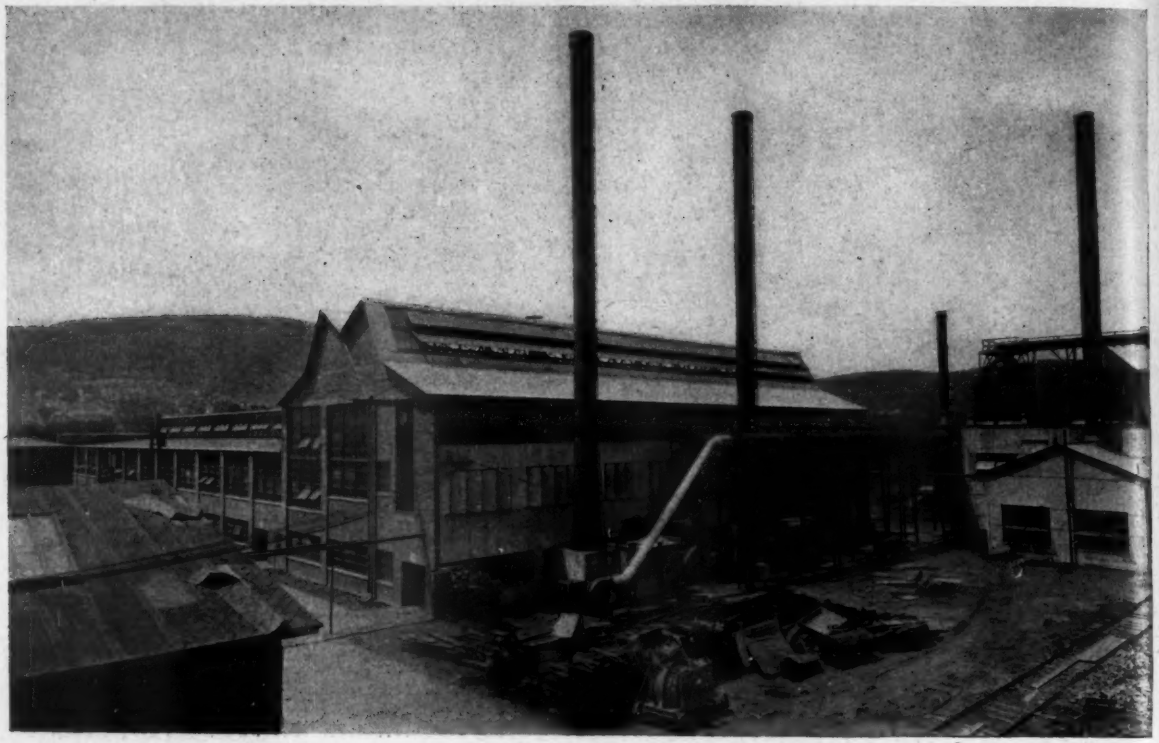


FIG. 1. REAR END OF TANK HOUSE SHOWING STACKS, GAS MAINS, SOOT INCINERATORS, CYCLONE COLLECTOR, ALSO BOILER AND PRODUCER HOUSE

siding and sash removed would be salvaged and used for the west wall of the future building.

The boiler and producer are adjacent to one another in a single building, which has a structural steel frame with steel sash, transit siding and roofing and concrete floors. By placing them in this manner one man will handle both the boiler house and the gas producer.

The mixing room is an old brick building with wood roof,

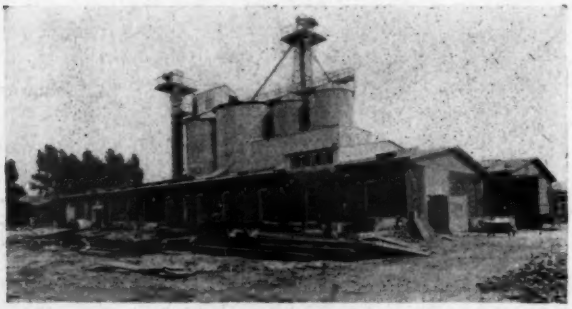


FIG. 2. VIEW OF MIXING HOUSE WITH CULLET BIN AND ELEVATOR TO THE LEFT

reconstructed by the addition of overhead bins into a modern batch mixing plant. All buildings are glazed throughout with "Velvex" and rolled wire glass, supplied by the Blue Ridge Glass Corporation, of Kingsport, Tennessee.

Equipment

For coal handling an eighty-ton bin has been placed above the producer and a similar one above the boilers. Coal is delivered to these by dumping from a car to a track hopper. A feeder takes the coal from the hopper and feeds it either to the crusher or by means of a by-pass to the elevator boot. A bucket elevator elevates the coal above the bins and discharges onto a chain conveyor which carries the coal to either of the bins.

All bulk mixing materials are unloaded from the car by a power shovel. A bucket elevator carries the material above any one of the three bins and by means of spouts and gates delivers it to the proper bin. A hollow-tile silo is provided for sand, and conical bottom steel bins for feldspar and soda ash.

A hopper in the mixing room at floor level delivers cullet to a roll crusher equipment with manganese fittings. The cullet is then conveyed over a magnetic separator to the boot of a bucket elevator, which in turn discharges through a double spout to either half of a divided silo type bin.

Packaged materials are unloaded on a barrel conveyor and stored on the main floor along the walls. A barrel elevator serves the mezzanine floor in order that a day's supply of these materials may be raised above the mixer, shoveled by hand to a hopper scale and discharged to the mixer below.

All bins discharge to a scale hopper below them. The scale hopper discharges directly into a traveling mixer which in turn discharges at one end of its track into a specially constructed batch hopper placed in a pit.

A batch hopper, when filled, is raised from the pit by an electric hoist and placed on a gasoline industrial truck which delivers it to the rear of the tank house. A second electric hoist on a monorail running back of the tanks raises the

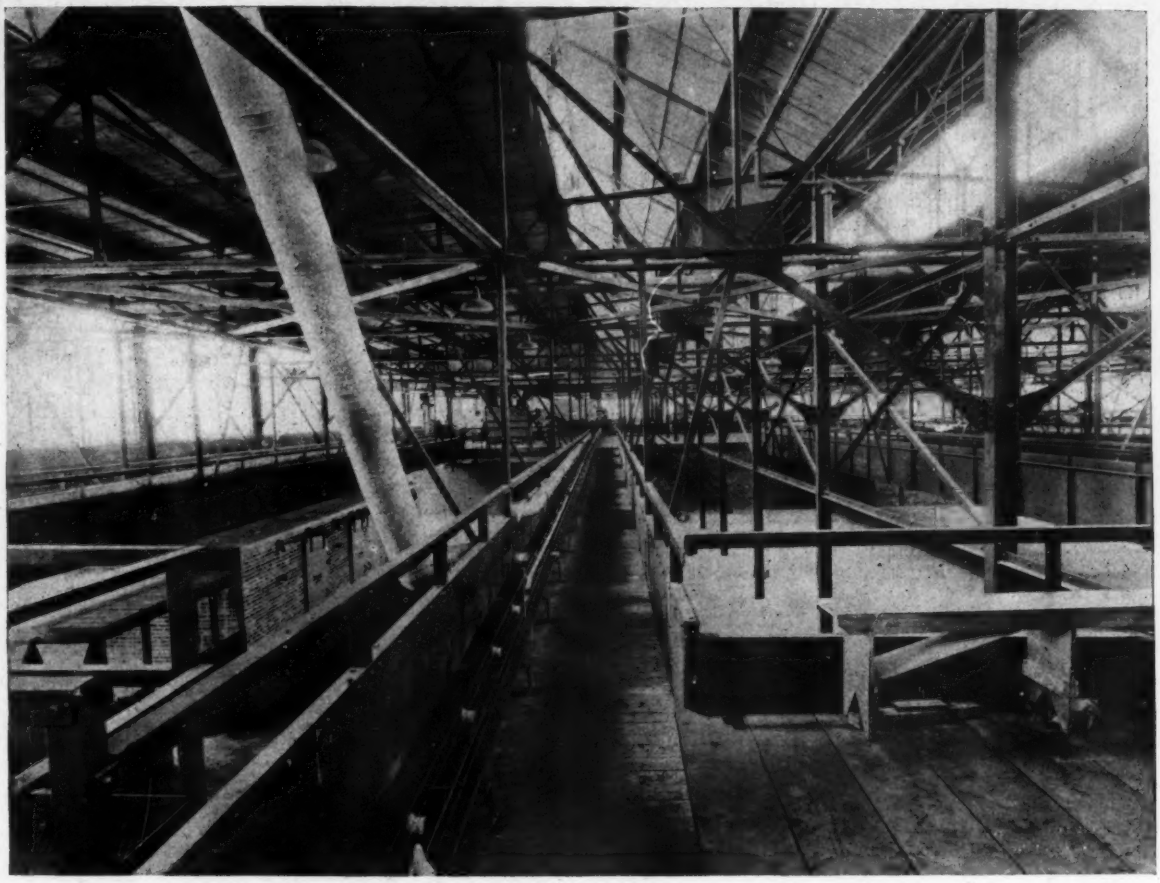


FIG. 3. LONGITUDINAL VIEW FROM TANK HOUSE LOOKING ALONG TUBE RUNS TOWARD THE FINISHING FLOOR AND FRONT OF BUILDING. NOTE UNOBSTRUCTED STORAGE AREA OF GROUND FLOOR

hopper from the ground and places it above a Hazel-Atlas feeder serving the tank.

The mixer capacity is 40 cu. ft. or about 4,000 lbs. of mixed batch and cullet. The hopper capacities are the same as the mixer and one hopper will serve a tank for three hours.

The gas producer is the eight foot size of The Wellman Engineering Company, equipped with a Coppus turbo blower and a Chowning regulator. The gas from the producer passes first into an eight foot cyclone soot collector and then through the mains to the tank. The gas mains are of ¼" steel plate lined with 2½" Armstrong insulating brick and 4½" of Harbison & Walker Woodland brick.

Power Services

Before deciding upon the heating system, the merits of high pressure boilers with electric generators and using the exhaust steam for factory heating was compared with a simple low pressure heating system and purchased power. The latter was finally decided upon, and two 125 H.P., H.R.T. Union Iron Works boilers were installed. These are served by Westinghouse under feed, single retort, side dump stokers. Forced draft is furnished by Coppus blowers. The feed water is treated in a Permutit Zeolyte softener before being pumped to the boilers by Cameron steam driven reciprocating pumps.

Fuel oil is circulated by means of two Gould triplex pumps, two Elliott strainers, and two Ross oil heaters.

Gas is taken from the city mains and boosted to two pounds per square inch by two American Gas Furnace Company's rotary boosters.

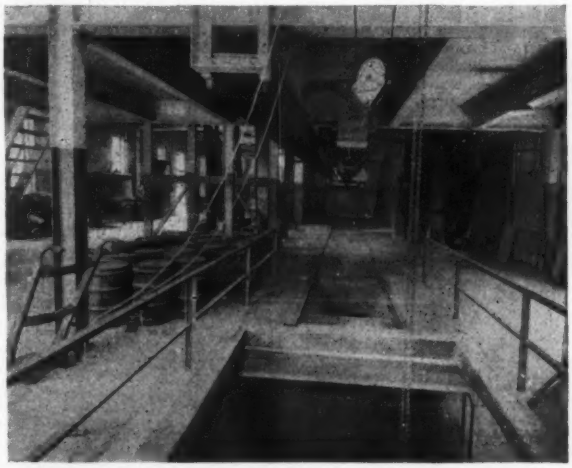


FIG. 4. LONGITUDINAL VIEW OF BATCH MIXER SHOWING TRAVELING MIXER AND PIT ABOVE WHICH MIXER DUMPS, ALSO WEIGH HOPPERS AND SCALES. NOTE BATCH CONTAINER ON LEFT FOR HANDLING MIXED BATCH AND CULLET

FIG. 5. EAST ELEVATION OF MAIN BUILDING WITH TANKS IN REAR

Eventually two circuits will provide electric energy to three 2200 volt primary, 440 volt secondary transformers and to one 2200 volt primary, 110 volt secondary transformer. Power equipment is supplied through the General Electric switchboard, on essential and non-essential circuits, at 440 volts, 3 phase, 60 cycle. Necessary D.C. is supplied from one of a pair of General Electric motor generator sets.

Low pressure air is used for most operations, although one 500 C.F.M. 40 pound machine is used for processes requiring medium pressure air. No duplicate for the 40 pound compressor is installed as it operates only during the day shift.

Glass Melting Tanks

Two regenerative producer gas fired tanks were constructed each of 12 ton capacity. The melting ends are 9′ 0″ wide x 15′ 4″ long, refining ends 9′ 0″ wide x 6′ 0″ long with front wall corners cut off at a 45° angle, providing connections for two Danner horizontal type tube drawing machine reheaters per tank. The depth of blocks is 24″, providing for 22″ of glass. Bottom, side and end walls, throat, bridgewalls, reheater connections and doghouses are constructed of Corhart Electro-cast refractory blocks, the product of the Corhart Refractories, Inc., of Louisville, Kentucky.

Each tank has three sets of producer gas and air ports per side for cross firing. Tank breastwalls and caps are built with 12″ silica brick. Ports and regenerators, including checkers down to the rider-arches are constructed of 9″ silica brick; all the walls are 13½″ thick. Rider arches and walls are first grade fire brick flues to reversing valves and stacks are second grade fire brick with red brick. Wellman-Seaver-Morgan producer gas and air reversing valves were used; the stacks are of steel, self-sustaining, 4 feet in outside diameter, with 4½″ brick lining and are 90′ 0″ high. Each tank provides for two Danner horizontal tube machines, having tube runs of 160 ft., 180 ft. and 200 ft. lengths of tube-draws.

In addition to the tanks, two kilns were provided in the furnace room. One is a trough kiln having a capacity for burning two reheater troughs, four gates and four spouts. The other is a service kiln for preheating the burned gates and mandrels prior to placing them in the reheaters as production may require. These kilns are all of direct fired type for both fuel oil or natural gas.

As stated above, the new Fall Brook Plant of the Corning Glass Works has an initial capacity of four Danner horizontal type tube drawing machines, with space provision for the fifth and sixth in the buildings and a ground layout such that only minor building changes are required for the addition of the seventh and eighth machines. While this ultimate capacity is considerably greater than the present business demands, it was provided for, so that any expansion in the requirements for tubing or cane could be quickly met and customers thus assured of an adequate supply.

Data for this article was supplied through the courtesy of Corning Glass Works.

A New Glass Journal

Revue Belge des Industries Verrières. (Belgian Review of the Glass Industries.) Boulevard Audent 6, Charleroi, Belgium.

Under this style and title a new periodical came into existence in March of this year. It appears monthly, and so far three issues have arrived in our hands. It is sponsored by a number of glass companies operating in Belgium, including Libbey-Owens, and the leading editorial of the first issue states that the reason for its appearance lies in the fact that, while Belgium has been for long a glass-country of the first importance, its technical literature and trade organs have been of the poorest.

This situation is certainly anomalous, and we hope that the new journal will do something towards rectifying it. As a matter of fact, however, the development of a respectable literature for the glass industry is of very recent growth in any country. The foundation of the Society of Glass Technology in England was the event that started the ball rolling, and the formation of somewhat similar societies in America and Germany was partly prompted thereby. Thus Belgium is not so far behind the times, and we hope it will soon catch up, for there is need for a journal in French to bring matters of import to the industry.

The issues so far received contain some leading articles by Belgian engineers and technicians written specially for the Revue, and a number of translations of works of writers in English, such as Dr. C. J. Peddle, and our own late technical editor, Mr. J. B. Krak.

We wish the new Review all success.

The Cost of Excess Air— Producer Gas Fired Glass Tanks

By JOHN W. ROMIG, M. E.
Corning Glass Works

THE easiest way to keep the thermocouple reading of the temperature of a glass tank is to feed in fuel and air in quantities such that the reading is at the prescribed point on the pyrometer dial or chart without observation or consideration of combustion conditions. If there is a tendency for the temperature to climb too high the air supply may or may not be cut with the gas supply. Perhaps the teaser will cut both, again only the gas supply may be decreased and the air kept the same as for a greater amount of fuel. If this is done the percentage of excess air immediately increases and the effect of the increased volume of air per volume of gas naturally cools the tank. If the temperature as shown by the thermocouple is low the teaser may try to make a very sharp fire, for this kind of a fire has a stimulating effect on a thermocouple, particularly so if the couple is in the tank crown. It is also quite common in tank teasing to set the air for a certain flow of fuel and changes are made only when some irregularities turn up and interfere with the blissful routine. The result of such practice is to provide an excess of air at all times, the excess in percentage being considerably higher at some times than at other times, depending upon the rate at which fuel gas is admitted.

The addition of more air than is necessary carries into the tank combustion chamber extra oxygen and nitrogen which must be heated. The excess contains a large amount of heat at the melting chamber temperature. Part of this heat is transferred to the checker brick in regenerative type tanks or through tile in recuperative type tanks but a good share of the heat in the excess oxygen and nitrogen is carried up the stack and is lost. The loss is equal to the additional gas required to heat the extra air after the regenerator recovery has been subtracted. In other words, if a tank is carried at 2600° F. with a high percentage of excess air, the temperature would rise if the excess air were cut and to compensate for the rise the amount of gas supplied would have to be reduced.

The subject of excess air percentages, the effect of excess air and fuel losses attendant on excess air often arises in the operation of glass tanks, but as a rule action taken for its control is limited. Heat losses due to excess air are believed by some to be of considerable magnitude while others prefer to consider them as negligible. There are losses of real magnitude in some instances as will be pointed out and shown in terms of dollars and cents. For proper combustion an excess of air is essential. The loss due to the minimum percentage required for complete combustion may be termed as the minimum loss or the practical operating fuel cost balance. Percentages over the minimum represent the loss that actually exists.

An Orsat analysis of waste gas will show some carbon-monoxide if combustion is incomplete while if combustion is complete there will be no carbon-monoxide but an excess of oxygen. In both cases carbon-monoxide is present. The presence of carbon-monoxide in a waste gas represents a direct fuel loss in unconsumed combustible that passes through the combustion chamber without releasing its heat of combustion when it unites with oxygen. As a rule when the carbon-dioxide percentage is highest there will be some carbon-monoxide present. On the other hand a loss equivalent or greater to that in the case where carbon-monoxide is present may exist if more air than the minimum for complete combustion is admitted.

The Orsat analysis of a waste gas shows only CO_2, O_2 and CO. In addition to these products H_2O and N_2 are present in the waste gases. (Nitrogen, the largest item in waste gas is found by difference during the analysis of the sample in which the water vapor has condensed.) The water vapor is condensed in the sample so the magnitude of this constituent is difficult to ascertain by analysis; therefore, in order that it may not be omitted, theoretical calculations are made to secure the volume of water vapor in the waste gas from one unit of fuel gas. Water vapor content of a waste gas from producer gas, is dependent upon moisture in the coal, combined hydrogen in the coal, excess steam admitted to the gas producer and upon the moisture driven from the raw materials, entering the melting chamber. The water vapor is in the form of highly superheated steam as it leaves the combustion chamber.

The carbon-dioxide percentage varies with the charging of raw materials, the constituents of the batch, the method of charging, whether constant or intermittent, and the time of taking waste gas samples as referred to charging periods. For this reason and because high CO_2 may exist with a presence of CO, the CO_2 percentage of a waste gas cannot be used in the development of combustion control. Instead of using the CO_2 percentage as the control basis of operation, the oxygen percentage is recommended because the analyses of the oxygen percentage will not be affected to any appreciable extent by the CO_2 content of the waste gases; then too, the oxygen content shows whether an oxidizing or a reducing atmosphere exists in the combustion chamber.

In an actual instance it was found that the error in oxygen was 3.8 per cent and the error in CO_2 was 6.7 per cent due to the gases evolved from raw materials charged. As a rule the oxygen percentage is about one-fourth the CO_2 percentage so the error in oxygen content is negligible when compared with the accuracy of an Orsat.

Tank men should operate a tank air supply from visual observation of flame length after having been allowed to study flame conditions along with waste gas analyses. If observations and waste gas analyses are frequent and enthusiasm is kept up this method produces good results. In connection with this method of operation it is necessary to determine what O_2 percentage is the maximum allowable,

what percentage is the minimum allowable and the average which should be carried. When tank teasers have become familiar with flame conditions and attendant Orsat results, adjustments are readily made for the desired percentage of O_2 in the dry waste gases. In many cases the temperature of a melting chamber can be increased by merely reducing the air admitted—this points directly to the losses of heat by admitting more air than is needed.

In order to point out the magnitude of losses, the case of a continuous regenerative glass tank requiring gas from 25 tons of $4.50 (net ton) gas producer coal per 24 hours, will be taken. The losses due to admission of more air than the assumed minimum are developed and particularly interesting steps in the development shown in tabular form so that the method can be used as a guide to anyone desiring to develop the cost of excess air losses.

Table I shows the analysis of the coal.

TABLE I

Moisture	3.0	per cent	by	weight	as fired	basis
Total Carbon	80.0	"	"	"	dry	basis
Hydrogen	6.0	"	"	"	"	"
Oxygen	5.0	"	"	"	"	"
Sulphur	1.0	"	"	"	"	"
Nitrogen	2.0	"	"	"	"	"
Ash	6.0	"	"	"	"	"

B. t. u. in coal as received — 14,300 per pound.

The coal is admitted to automatic gas producers and gasified. The average gas analysis is shown in Table II along with producer and tank data.

TABLE II

Carbon-dioxide	5.0	per cent	by	volume	(dry gas)
Carbon-monoxide	26.0	"	"	"	"
Hydrogen	12.0	"	"	"	"
Methane	3.5	"	"	"	"
Nitrogen (by difference)	53.5	"	"	"	"

Ethane and Illuminants—Negligible.

Combustible in ash.....10 per cent by weight
Steam admitted.....0.4 pounds per pound of coal
Carbon and tar leaving producer,
0.00022 pounds per cu. ft. producer gas
Carbon and tar entering test,
0.00007 pounds per cu. ft. producer gas
Temperature of tank.....2,600° F. in melting chamber
Temperature waste gases.....900° F. at stack damper

Using the data shown in Tables I and II combustion calculations are carried out according to the methods shown in the article, "Economics of Producer Gas, Fuel Oil, and Natural Gas Compared" which appeared in THE GLASS INDUSTRY in five parts beginning with the December, 1929, issue. The results summarized are:

Cubic feet of producer gas from one pound coal = 72.5.
Theoretical heating value cold gas = 149.5 per cu. ft.
Theoretical air required for 1 cu. ft. producer gas = 1.25 cu. ft.
Water vapor from producer gas per cu. ft. = .07 cu. ft.
Water vapor combustion of producer gas per cu. ft. = .26 cu. ft.
Nitrogen from producer gas per cu. ft. = .535 cu. ft.
Nitrogen from theoretical air per cu. ft. = .99 cu. ft.
Carbon dioxide from combustion per cu. ft. = .345 cu. ft.
B. t. u. net delivered and absorbed in the combustion chamber—per pound of fuel = 9080.

The setting up of the above data and calculated values looks formidable but after the procedure has once been established the effort required is very small especially if typewritten forms are made as a guide. The producer gas analysis should be an average over a period with a given coal. The results will not vary appreciably with a given fuel under constant gasification conditions. So in the study of the losses it is not necessary to make frequent checks—one series of calculations will generally suffice until the fuel supply or gasification conditions are changed.

The absolute minimum loss of heat in waste gases exists when combustion is complete and there is no excess air. This minimum is theoretical and cannot be maintained in practice. However, in carrying out calculations to determine the extent of losses this figure has a value. Table III below shows the absolute minimum loss of heat in waste gases evolved under conditions previously given.

TABLE III

Constituent in waste gas	Cu. ft. of constituent per cu. ft. producer gas	Heat in 1 cu. ft. constituent at 900° F.	B. t. u. carried out of stack flue.
CO_2	.345	27.0	9.3
O_2	0	16.9	0
Air	0	16.9	0
N_2	1.525	16.9	25.9
H_2O	.26	20.4	5.3
Total			40.5

A study of Table III reveals that one cubic foot of air, oxygen or nitrogen at 900° F. will carry out 16.9 B.t.u., water vapor will remove 20.4 B.t.u., while carbon-dioxide will remove 27.0 B.t.u. Excess water vapor due to admitting too much steam to a gas producer is a cause of small losses of heat; high moisture content of coal is another source of loss. The total loss of heat in the gases passing to the stack amounts to 40.5 B.t.u. for each cubic foot of producer gas, this being the minimum theoretical loss.

The heat losses over the minimum loss are shown in Table IV for varying percentages of excess air. The right hand column shows the B.t.u. loss per 24 hours over the minimum theoretical loss. It is the product of the heat loss over and above the minimum, the number of cubic feet of gas per pound of coal and the number of pounds of coal gasified per 24 hours.

TABLE IV

Per cent Excess air	Total Stack Loss	Minimum Loss	Loss over and above Minimum	B. t. u. loss per 24 hours in Millions of B. t. u.
0	40.5	40.5	0	146
25	45.8	40.5	5.3	166
50	51.1	40.5	10.6	186
60	53.2	40.5	12.7	194
70	55.3	40.5	14.8	201
80	57.4	40.5	16.9	208
90	59.5	40.5	19.0	216
100	61.6	40.5	21.1	223
125	66.9	40.5	26.4	243
150	72.1	40.5	31.6	261
200	82.7	40.5	42.2	300

From Table IV it is seen that the absolute minimum stack loss is 146,000,000 B.t.u. per 24 hours. This loss is more than doubled when the per cent excess air is raised to 200 per cent. As stack temperatures decrease the losses decrease and as stack temperatures increase the losses increase.

In Table V the losses have been converted into terms of dollars and cents. The economic loss cannot be computed on the basis of heat units in coal as the heat loss is direct

from the combustion chamber. It was found that in preliminary calculations 9080 B.t.u. out of one pound of 14,300 B.t.u. coal actually are used in the combustion chamber to melt raw materials and to overcome radiation losses. The fuel loss must therefore be computed by dividing the heat loss by 9080 instead of 14,300. The absolute minimum stack loss is shown in the second column from the right. It is impossible in practice to attain this result as an excess of air must be admitted to secure an oxidizing atmosphere in the combustion chamber and to insure a mixing of fuel and oxygen so that carbon-monozide or unburned fuel losses will be avoided. The practical minimum loss is taken with 50 per cent excess air.

TABLE V

Per cent excess air	Per cent O_2 by Orsat in waste gas	Heat loss in Millions of B. t. u. per 24 hours	Loss in Pounds Coal per 24 hours	Absolute Minimum Fuel Loss dollars per day	Loss in dollars per day 50% excess air Minimum
0	0.	146	16,100	36.20	....
25	3.1	166	18,300	41.20	....
50	5.2	186	20,500	46.10	0.
60	6.1	194	21,400	48.00	1.90
70	6.6	201	22,100	49.90	3.80
80	7.2	208	23,000	51.90	5.80
90	7.8	216	23,800	53.70	7.60
100	8.3	223	24,600	55.40	9.30
125	9.4	243	26,800	60.20	14.10
150	10.2	261	28,800	64.90	18.80
200	11.9	300	33,000	74.30	28.20

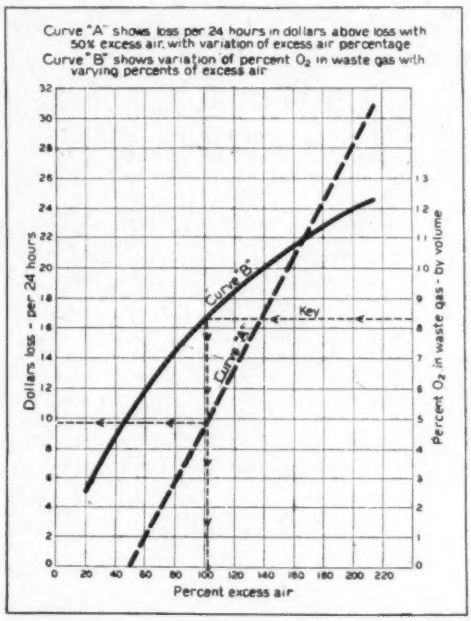
The practical minimum in Table V was taken under conditions involving admission of 50 per cent excess air which corresponds to an oxygen content of 5.2 per cent in the waste gas. As a rule the oxygen content of the waste gas can be kept between 3 and 5 per cent, usually nearer 3 per cent. However, in this case 50 per cent excess was used as the practical minimum requirement for the purpose of conservatism in the result, 50 per cent being somewhat on the high side as to practical minimum loss and on the low side in dollars and cents loss that can be avoided by proper control of excess air.

To illustrate the results the diagram shown was developed. Dollars and cents loss over the 50 per cent excess air minimum are tied in both with per cent excess air and oxygen content of waste gases. For an 8.3 per cent oxygen content in waste gases we find that 100 per cent excess air is admitted and that the fuel loss amounts to $9.30 per 24-hour day. If a tank operates 300 days per year under these conditions the loss amounts to a total of $2,790 in fuel only; steam and other gasification costs add slightly to the total fuel loss.

If the cost of excess air in natural gas or fuel oil fired tanks is desired for tanks operating with these fuels, the computations may be carried out in the same manner as the above except that the excess air is figures for the particular fuel. The losses shown by calculations for any fuel give an indication of what room there is for improvement in tank fuel economy and may be considered as a target to shoot at in operation.

It is not necessary to carry out the calculations as above shown more than once or twice for a given fuel (the second calculation being a check on the first). Once average fuel and operating conditions have been determined, the calculated results are useful in establishing the O_2 percentage for operation and the connection between O_2 percentage per cent of excess air and the loss in dollars and cents. Having the results they are applied in the field by operating with the O_2 percentage found to be the balance between loss in combustible, excess air and good glass quality. A boy can soon learn to take waste gas samples and make analyses. Foremen should be taught the principles of combustion and what adjustments to make when the O_2 percentage is high or low. He and the teaser should be shown the connection between flame length, color and action and the O_2 content of waste gases. Having done the above the combustion problems are well on the way toward solution and only occasional laboratory checks are necessary to keep it in continuous control.

There certainly is room for a more comprehensive study of combustion in glass tanks. The expense of carrying out


Curve "A" shows loss per 24 hours in dollars above loss with 50% excess air, with variation of excess air percentage
Curve "B" shows variation of percent O_2 in waste gas with varying percents of excess air
Curve "B"
Key
Curve "A"
Dollars loss - per 24 hours
Percent O_2 in waste gas - by volume
Percent excess air

CURVES ILLUSTRATING LOSS RESULTING FROM USE OF EXCESS AIR IN GLASS MELTING TANKS

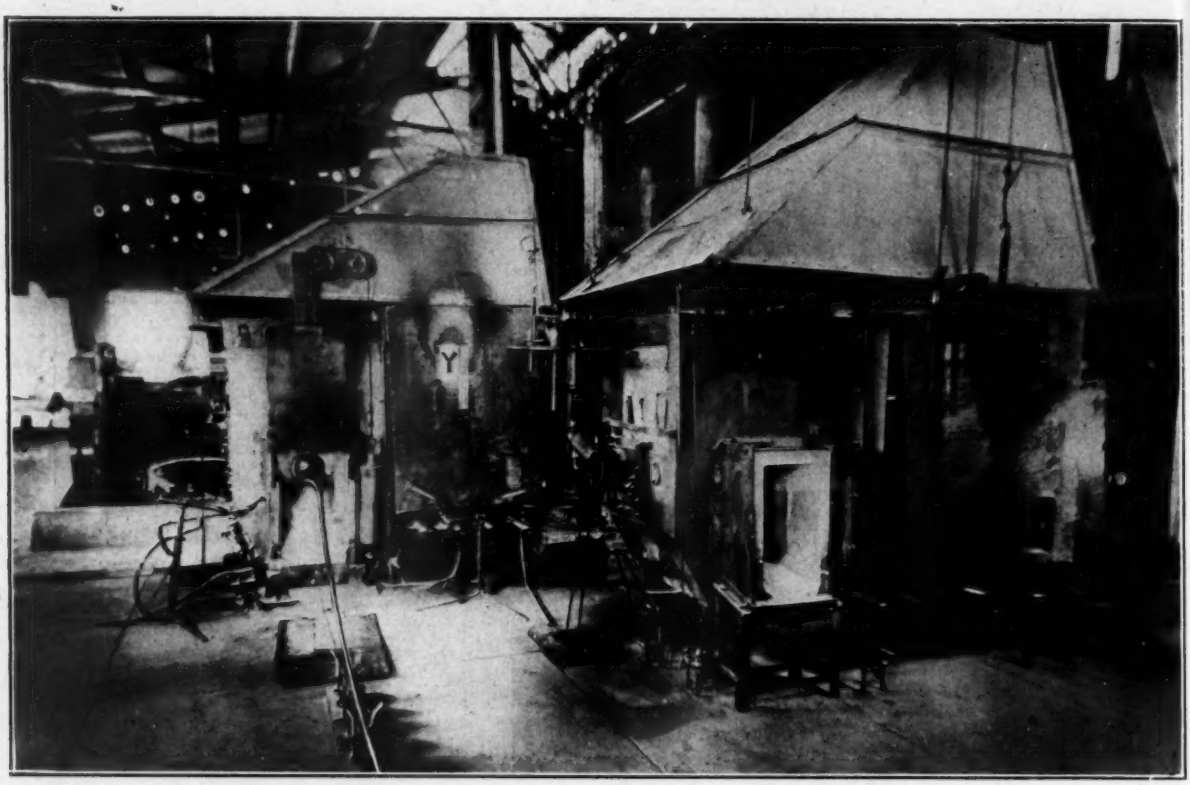
such studies and applying the results will in most cases give in return a handsome profit. In modern boiler practice the excess air percentage is very important and maximum efficiency is secured only when the excess air problems have been solved. In the case of boiler practice much experimentation has developed standard percentages of excess air but little has been done in the case of glass furnaces. Because of the small amount of information available it is a problem that must be attacked by each manufacturer as an individual. The savings are worthy of consideration and are easily obtainable at low cost, the greatest part of which is the cost of educating the teasers and foremen in the ways of proper combustion.

Danner Process of Tube Drawing

JAMES BAILEY[1]

MOST of the commercial glass tubing and rod on sale in this country is now made by the Danner process which, with suitable modifications, is used in the new Fall Brook Division of the Corning Glass Works, an article on which appears in this issue.

The Danner process is covered by patents issued in 1917 and assigned to the Libbey Glass Manufacturing Company who have licensed its use to a very few large manufacturers. Knowledge of this process is therefore not general and the following brief description based upon the existing literature should be of particular interest at this time.



REHEATING END OF FURNACE SHOWING TROUGHS AND ARBOR

Glass is usually melted in a tank of conventional design although somewhat smaller than the common bottle tank, and with a relatively small working end, as but two machines are customarily operated from one tank.

Glass flows from the tank first into a conditioning chamber in which it is skimmed and its temperature accurately adjusted, then down a chute onto a slowly revolving hollow mandrel. The flow of glass is accurately controlled by a gate which may be opened or closed by means of a screw and hand wheel.

The mandrel is a clay sleeve of suitable size mounted upon a hollow shaft and enclosed in a heated muffle. The shaft and its drive are designed to permit its axis to be tipped downward to the best working angle which is usually about 20 degrees.

The stream of glass impinges upon the mandrel near its upper end as it winds around it, and is given a downward axial flow by gravity. The stream thus appears to be wound around in a helix like the layers on a spool of thread. The helical waves, at first, apparently smooth out and gradually disappear so that before the glass is drawn off the end of the mandrel, it has reached a uniform condition both as regards thickness and temperature.

When tubing is being made, a steady stream of air is blown through the hollow shaft into the interior of the tube. Since the internal air pressure largely determines the relation of inside diameter to wall thickness with a given speed of drawing, the air pressure must be carefully regulated.

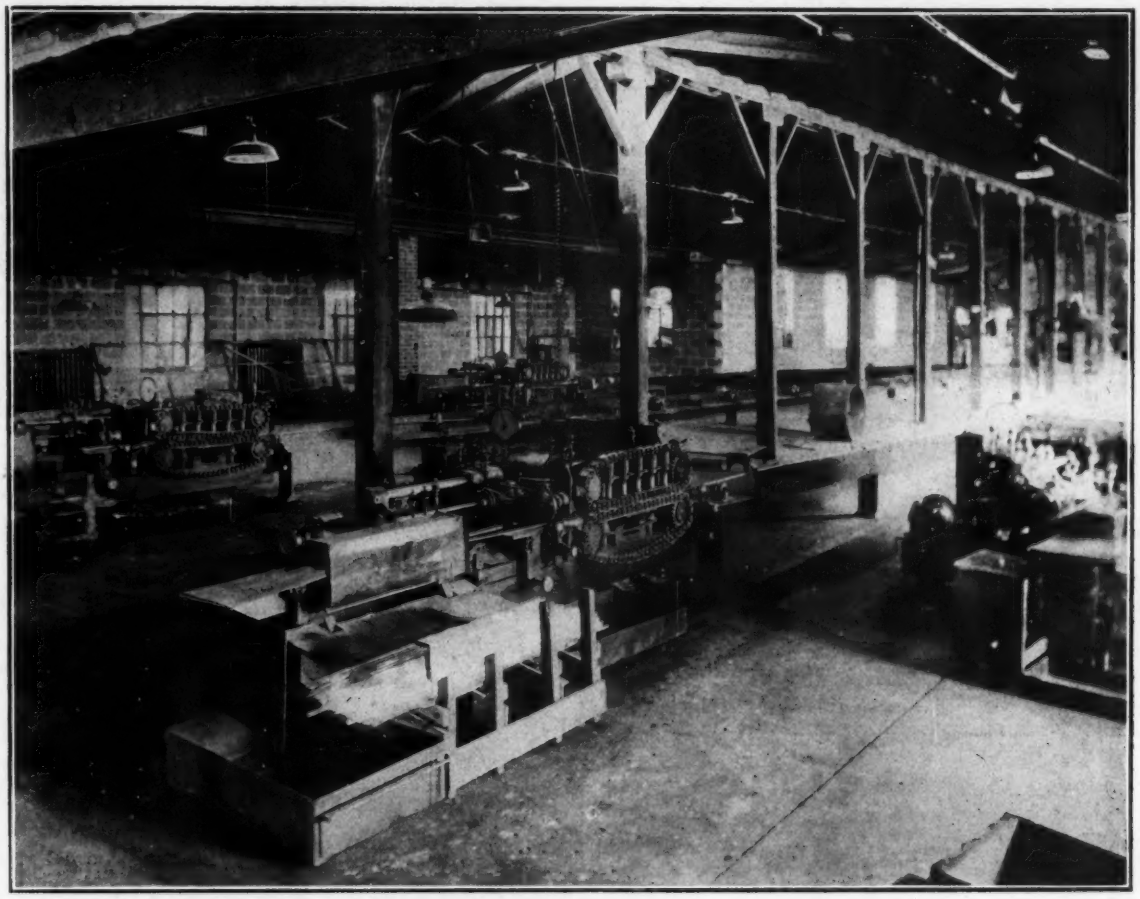
The change from tube to rod is made by shutting off the air completely or by fitting a plug into the lower end of the mandrel.

Because of its revolution, the glass takes a peculiar curve as it is drawn from the mandrel. This is clearly shown in the accompanying illustrations[2] which are reprinted from THE GLASS INDUSTRY of May, 1921. These pictures show the approximate size of the mandrel and give an idea of the way the size is reduced as the velocity of drawing increases.

[1] Bailey & Sharp Co., consulting engineers and glass technologists.

[2] From the Kimble Glass Co., Vineland, N. J.

The glass as it thins down loses heat very rapidly so that by the time it has moved 15 or 20 feet from the mandrel it is too stiff to appreciably change its shape and may then be guided on a series of grooved pulleys without being damaged. The pulleys are mounted on bearings which are as nearly frictionless as possible and are caused to revolve by the friction of the glass upon them. By so doing the changing velocity of the glass as it elongates is automatically taken care of and any rubbing reduced to a minimum. The pulleys also reduce the amount of pull necessary to keep the tube in motion.



GLASS TUBE PULLING MACHINE SHOWING POSITION OF SAW IMMEDIATELY AFTER CUTTING TUBE TO LENGTH

The space in which the line of pulleys is located is called the tube run, as in the ordinary hand process, but in the case of Danner process it assumes considerable lengths. In 1921 a speed of 140 feet per minute was obtained with lime glass and tubing $\frac{3}{16}$" outside diameter. This speed has, in common with other glass working processes, been greatly increased since that time so that, now, the tube runs are made up to 200 feet in length, in order to give the glass time to properly harden before entering the pulling device.

At these high speeds, and considering the brittleness of the glass and the liability of irregularities due to stones, etc., the pulling device must be very carefully designed to avoid breakage of the tube. This has been cleverly worked out as shown in the illustration. It consists of two chains each running around two sprockets, and arranged one above the other in a vertical plane. The chain pins have wheels on them which run on tracks for the length of the two middle laps. There are also asbestos pads fastened to the chain links so that the tube which is fed between the laps contacts with no metal. The upper lap of the lower chain is guided in a straight line by a track upon which the chain wheels run. The lower lap of the upper chain is yieldingly pressed downward against the tube by making its track in sections each of which is pushed downward by a spring. The distance between chains is therefore able to adjust itself to suit minor changes in the tube diameter. This method also allows sufficient pull on the tube while the squeezing action of the puller is never very great. The tube is fed centrally between the chains by guide wheels which are shown in the illustration.

The mechanism is designed so that simple adjustments permit the handling of different sized tubes. The whole is driven by a variable speed motor and suitable gearing so that speed change is a quick and easy matter.

Upon issuing from the puller, the tube is automatically cut into the desired lengths and delivered to a rack. In most plants the tube is gauged automatically and separated into series of sizes.

From this brief description, it is apparent that the forma-

tion of the tube is similar to the familiar hand process, in that a body of conditioned glass is worked into a thick, heavy cylinder which is drawn out into a small long tube, and to a great extent the factors involved are the same. The thickness and size of the glass on the mandrel, its temperature, the internal air pressure, and the speed of draw are all determining factors in the size of the resulting tubing.

It has, however, the difference that it is a continuous process so that once the various factors are properly adjusted, the resulting tubing will continue to be formed of like diameter and wall thickness. It is of course necessary to carefully watch the size of the tubing and to make adjustments as may be required. These adjustments are now well understood and tubing of remarkable uniformity can now be made.

In the original disclosure of the Danner patent a number of modifications of the mandrel were described. These have not been included in the above description because so far as is known they are not being used.

CONTINUOUS TUBE OF GLASS BEING DRAWN FROM DISCHARGE END OF BLOW PIPE

Solarization of Glass

QUITE a debate seems to have geen going on in the columns of *Nature* and our English contemporary, *Glass,* between Messrs. A. R. Wood and M. N. Leathwood, of the Crown Glass Works, St. Helens, and Dr. S. English, of Holophane, Ltd.

In *Glass,* September, 1928, English states that exposure of an ultraviolet transmitting glass to the rays of a mercury vapor lamp for eight hours is equivalent, in its reducing power on the transparency, to six months of sunlight.

In *Nature,* September 21, 1929, Messrs. Wood and Leathwood report that complete degeneration by a mercury arc lamp results in a greater loss of ultraviolet transparency than does natural solarization.

In *Nature,* January 18, 1930, English suggests that this is essentially a confirmation of his earlier report that degeneration proceeds more rapidly in the arc light than in the sun light.

In *Nature,* March 8, 1930, the St. Helens' workers resent this suggestion, and point out that their main conclusion is that an eternity of sunshine would not produce so much loss of transparency as would just a couple of hours' exposure at a few inches from a mercury arc.

Further, they have shown that when a glass has been deteriorated by a mercury arc, exposure to sunlight improves or rejuvenates it to an appreciable extent. In other words there seems to be some equilibrium condition of transparency, to which a glass will come by sufficiently long exposure to a particular sort of light. If the glass is too transparent, it will darken; if it has been spoiled and made too opaque to the ultraviolet, it will improve and become less opaque. The light brings the glass to the proper equilibrium condition in due course.

* * *

Since it has been shown at Sheffield and elsewhere that the absorption-increase on exposure to light is due in a great measure to the oxidation of ferrous iron to the ferric state, the new work of Wood and Leathwood seems to imply that improvement in sunlight of a glass that has been spoiled by the arc, must be due to a reversal of the process, ferric iron being again reduced to the ferrous state.

It follows that in any glass the iron is in a mobile state, and adjusts its state of oxidation to equilibrium with the radiation to which it is exposed. This fact, it seems to us, may open up new avenues for the exploration of the physical constitution of glass.—F. W. P.

Since the above was written we have received a copy of a British patent issued recently to Chance Brothers for keeping the iron in a reduced condition by suppressing the dissolved gases in glass, and thereby eliminating the means for oxidizing the iron.—[ED.]

Annual of the Ceramists and Glassworkers of France

The tenth edition of the "Annuaire des Cèramistes et Verriers de France" was issued early this year in its usual form, 8½ x 5¾ inches in size, bound in stiff covers and containing 543 pages including advertising and information on the industries to which it is devoted. It is compiled by J. Hogrel and issued by the publishers of *Cèramique et Verrerie* which was founded in 1919 under the patronage of the Chambre Syndicale de la Ceramique et de la Verrerie. It is published at 13, Rue des Petites-Ecuries, Paris. (X²Arrt).

This publication contains what is understood to be a complete directory of the French glass and ceramic industries (in France, we are advised, glass is not classed as a ceramic product, either from the scientific or industrial point of view and both industries have their separate organizations, not associated, as they are in this country as exemplified by the Glass Division of the American Ceramic Society). It begins with a list of syndicates and associations interested in these industries, gives the names of members and associate members of the above-mentioned syndicate, classified by the products they manufacture, and a list of manufacturers' representatives and agents in the glass and ceramic industries, decorators, etc. A general list of adjusters and commission experts "du Government" is included. A large section is devoted to illustrations of trade marks. Many pages are devoted to lists of engineers, manufacturers of furnaces, machinery, raw materials, colors, etc. Another section is devoted to brick, tile, refractories, industrial and sanitary pottery, etc. A third section covers porcelain and faience manufacturers, another, glass and crystal. Section V has 64 pages given over to products of miscellaneous character, art editors, artists, decorators, etc., and business agents for many types of glass and ceramic products. A table of contents completes the volume.

The Rate of Crystal Growth in Technical Soda-Lime-Silica Glasses

By DR. ADOLF DIETZEL*
Translated by K. H. Lunde and F. W. Preston

(Concluded from the July issue)

§ 8. The Dependence of the Rate-of-Growth Curves on Chemical Composition

IN order to get a bird's-eye view of the devitrification-tendency of all the glasses as regards its dependence on their composition, the measurements were collected into one diagram. For simultaneous representation of the four variables, soda content, lime content, rate of crystal growth, and temperature, in one plane, Zschimmer's four-dimensional diagram was used. By choosing as ordinate and abscissa the temperature and rate of crystallization, and as constants, soda and lime contents, we obtain the diagram set out in Fig. 50.[21]

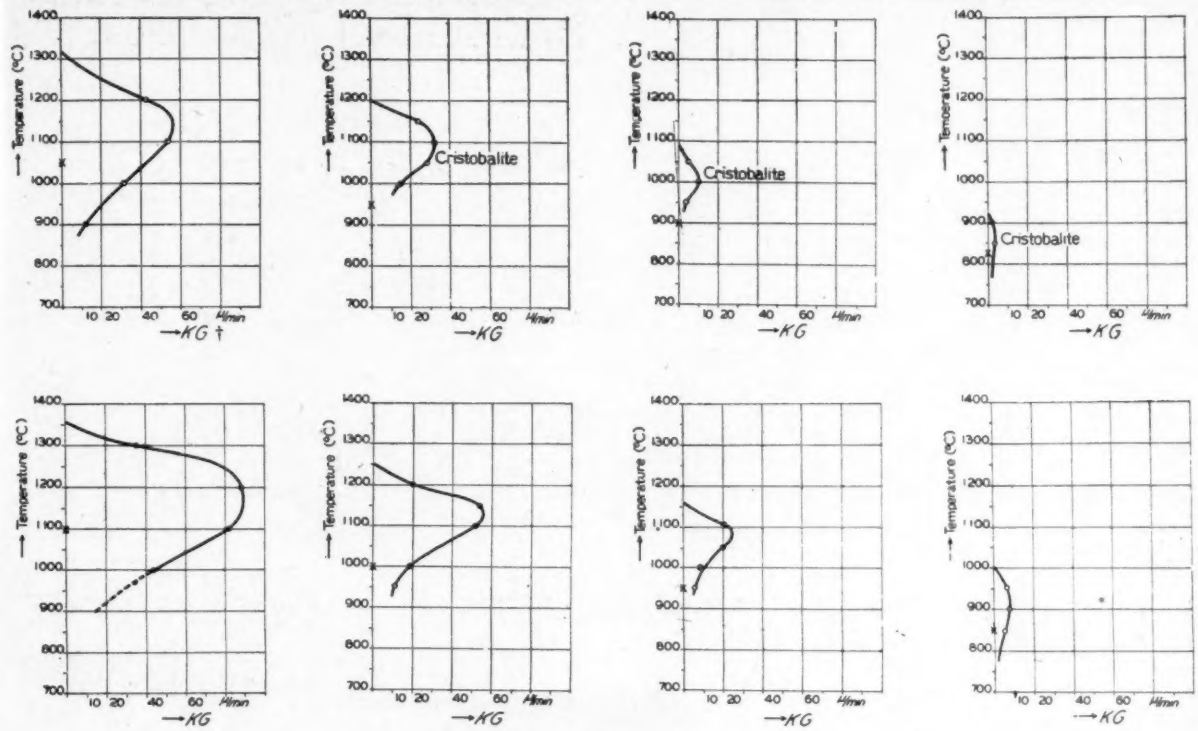


FIG. 50

Substitution of CaO as shown in the vertical columns of the diagrams, in the four sodium-silicate parent glasses, shows that at first the lime diminishes the tendency to devitrify but at higher concentrations causes the crystallization to increase again. The optimum content of CaO depends upon the soda content; it is as follows:

For 12% Na_2O about 14% CaO
14% Na_2O about 12% CaO
16% Na_2O about 10% CaO
18% Na_2O about 8% CaO

When soda is substituted for silica (as in the horizontal rows), its influence upon parent glasses whose CaO content is higher than 12%, is entirely opposite to its influence on parent glasses with less than 12% CaO.

This fact, of great importance for the glass industry, may be stated in the following terms: Among the lime-poor glasses, silica crystallizes out; raising the soda content at the expense of the silica causes a relatively pronounced diminution in the free SiO_2 content, probably assisted materially by the formation of double silicates. Among the lime-rich glasses, on the other hand, wollastonite is precipitated, and its concentration is not by any means so strongly influenced by the addition of soda. (In both cases the growth of crystals is naturally materially aided by the diminution in viscosity which follows as a consequence of an increased soda content of the melt.)

§ 9. Connection Between Rate of Crystal Growth and Viscosity

In the diagrams reproduced in Section 7 [Dietzel evidently should have written Section 6,—F.W.P.] there is given in each case the temperature at which the glass becomes so fluid that it takes on the form of the crucible within the ordinary duration of a devitrification experiment. Since now this change of shape is in the first instance a question of viscosity, we may take it as the first approxima-

* A communication from the Silicate Laboratories of the Institute for Chemical Technology, Karlsruhe Technical School; published in Sprechsaal (Coburg) 1929.

†KG means rate of crystal growth.

[21] Since the analysis of the glasses examined departed but slightly from the calculated composition, the curves are given in the diagram without corrections. The errors thus introduced lie within the errors of observation in determining the length of the longest crystals.

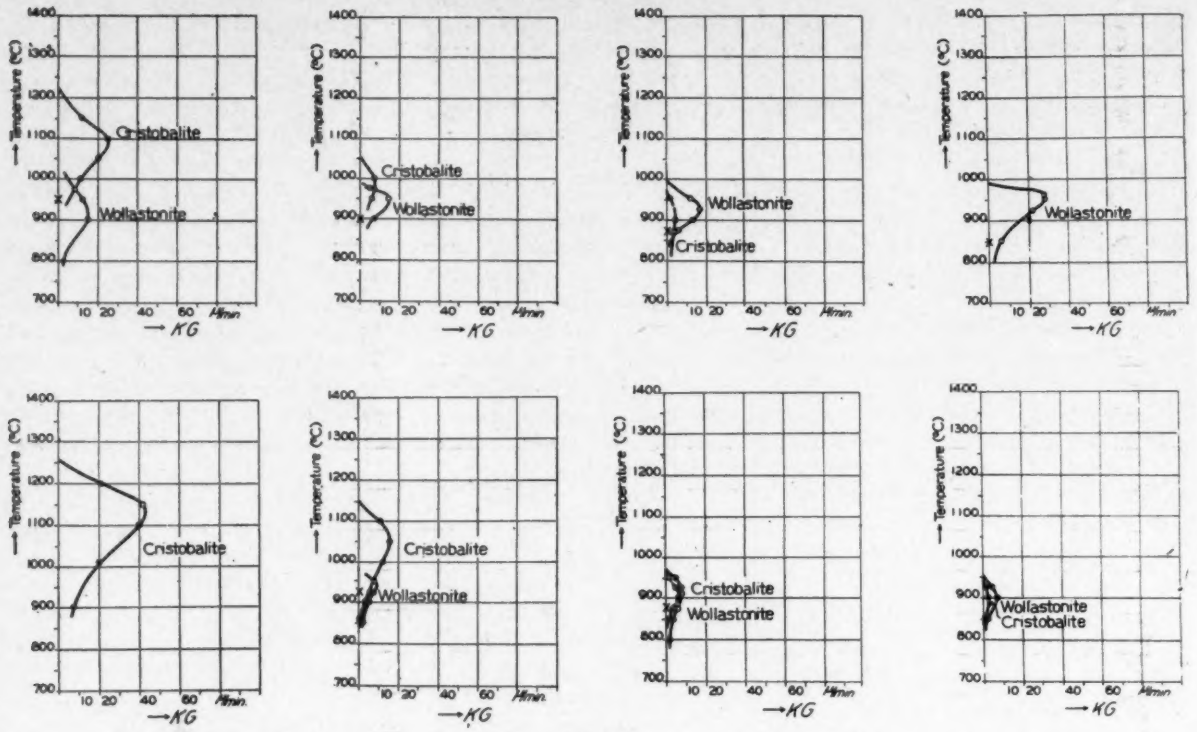


FIG. 50A

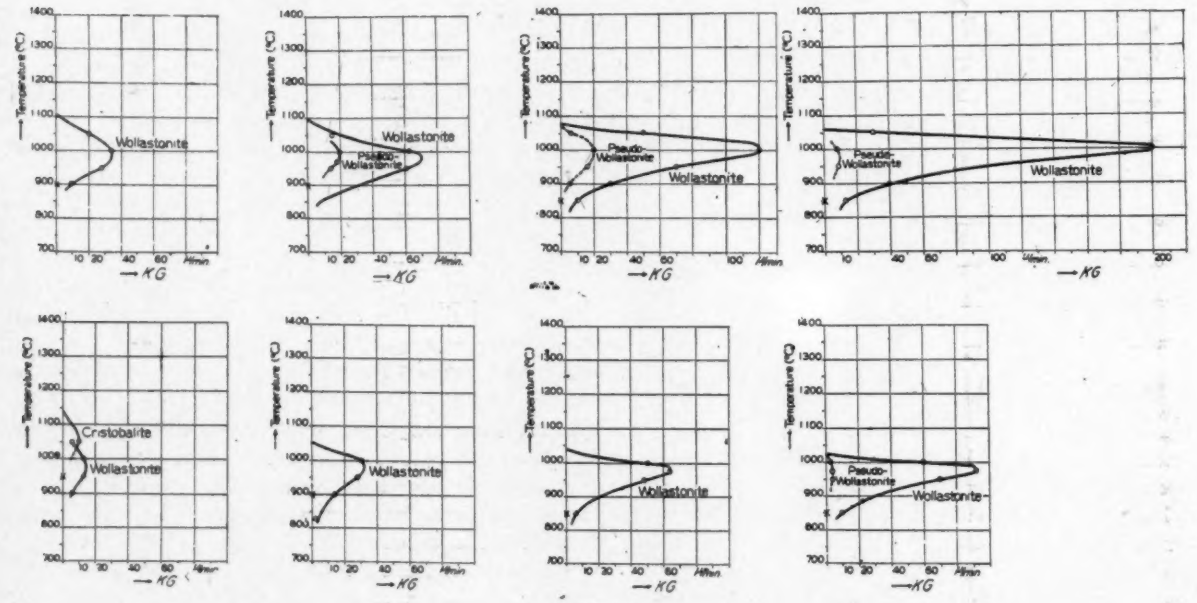


FIG. 50B

tion that, at the temperature thus specified, the various glasses have the same viscosity.[22]

It might be mentioned here that the absolute value of the viscosity for the majority of these glasses comes out, according to the diagram of Washburn and Shelton, at around 10^5 Poises, or in the case of the lime-rich much devitrified glasses at something approaching 10^6 Poises. It would seem, according to the viscosity measurements, that these melts had devitrified and gave on that account too high a value.

Between the position of the deformation temperatures (or temperatures of equal viscosity) and the curve of crystal growth-rate, there exists an interesting connection. With practically all the glasses this temperature marks the point at which the rate of growth rises with apparent suddenness to serious values, a point which in practice corresponds with

[22] Naturally the time of devitrification, the time for deformation, the surface tension, and the density are all concerned in this. Moreover, the temperatures were stepped up only in somewhat large intervals.

the so-called "lower limit of devitrification."[23] Evidently the viscosity of the glass must fall below a certain value (around 10^5 poises) before mobility of the molecules becomes sufficiently great to permit their arrangement in the crystal lattice in a short time.

From the diagram of Fig. 50 one further point may be noted concerning the viscosity. If we compare the lime-and-soda-rich melts with those rich in silica it may be observed that in the first case the growth curve rises sharply and falls away suddenly, while in the second case the curve pursues a much more even course. Here again the influence of the viscosity may be traced. It is sufficiently well known that the lime-rich glasses have an unusually sharp rise in stiffness as one approaches the lower end of the working temperature range; in other words, they are "short."

This rapid alteration is responsible for the sharp change of direction of the rate of growth curve.[24] The circumstances are quite otherwise among the "long" silica-rich, lime-poor glasses. The relatively gentle course of the viscosity curve with temperature explains the appearance of the growth curves in question.

§ 10. Isotherms of the Maxim Growth Rates and Isochrones of the Minimum Times for the Formation of Crystals of 10 μ in Length

From the four-dimensional diagram given in Section 8, one can read off the alteration in the temperature-devitrification curve, but only in steps of 2% in composition. Such large intervals of oxide content are, however, in many cases, too rough an approximation for the glass industry. Herewith therefore two diagrams are provided, in which are set

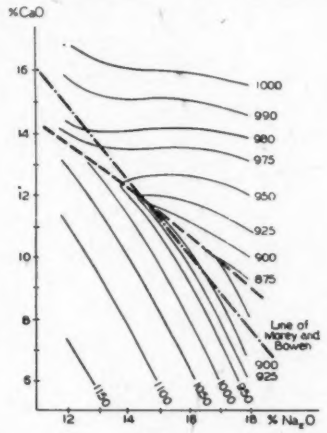


FIG. 51

forth, in the one case (Fig. 51) the isotherms of the maximum devitrification rate, and in other the isochrones[25] of the minimum times for the formation of crystals 10 μ in length. (Fig. 52.)

As regards the shape of the isotherms, the following point is worth noting. Considering the diagram in a broad sense, there will be found a slightly curved "valley" extending from the point 18% Na_2O 9% CaO to the point 12% Na_2O 13.7% CaO. Along this line the initial temperatures for glasses with less than 13.5% Na_2O fall off rapidly in the direction of increasing lime content, since the maximum growth-rate of wollastonite (which now becomes the deciding factor) lies at an appreciably lower temperature than that for cristobalite, which latter preponderates in glasses with a lower CaO content. Among glasses with more than 13.5% Na_2O the temperatures of maximum rate of crystal growth for the two phases lie close together; no abrupt transition therefore (from one phase to another) is found in such cases.

The trace of the said valley intersects at an acute angle the boundary line given by Morey and Bowen as separating the field of SiO_2 on the one side from the fields of β-wollastonite and the double silicate Na_2O, 3CaO, $6SiO_2$ on the other side. This implies that the temperature of maximum rate of growth does not always rise or fall in the same sense as the upper limit of devitrification when one alters the chemical composition.

These phenomena are explained among the lime-rich glasses by the observed transition of the greater maximum rate of growth from cristobalite to wollastonite, while still within the field of existence of cristobalite. Among the glasses with 14 to 18% Na_2O, and moderate lime-content the compound sodium tricalcium silicate should be precipitated, but this appears only under special circumstances. In its place cristobalite and wollastonite were observed in the present work. Both compounds extend also into the field of the double silicate and the valley line indicates the transition of the greater maximum growth rate from the one compound to the other.

Concerning the isochrone diagram the following remarks may be made: In comparison with the isotherm diagram the trace of the crotch or ridge line on the isochrone diagram (likewise broadly considered) tends to coincide more closely with the Morey and Bowen line. This means that glasses whose composition lies between these two lines, crystallize first at a lower temperature and correspondingly more slowly than glasses in the neighborhood. The crotch line has on that account therefore a particular practical interest.

§ 11. Practical Rules for the Composition of Melts Having the Least Possible Tendency to Devitrify

In choosing a composition to avoid devitrification, one will in the first instance take care, that the upper temperature limit of devitrification and the temperature of maximum rate of growth lie sufficiently low, and that the crystals in the under-cooled melt grow as slowly as possible. The question now is, in what fashion these requirements may best be met. In most cases the necessity for a sufficient durability on the part of the glass establishes a limit to the alkali content, and we then have to seek the optimum lime content which will produce an optimum glassy state. Now it happens that the conditions for most satisfactory upper limit

[23] An exception is found in the glasses containing 12% Na_2O; among the lime-poor examples (6 to 8% CaO) cristobalite is thrown out below the deformation temperature with apparently even greater velocity, and among the lime-rich ones (12 to 14%) wollastonite similarly; in the latter case, however, the behavior of cristobalite is normal.

[24] Here again the soda-poor glasses (containing 12% soda) with 12 to 16% CaO, constitute an exception. With these, the curve is not so steep as among the soda-rich melts mentioned. Inasmuch as the trend of the viscosity of these glasses is not yet sufficiently well established, the explanation of this fact may best be left open for the present.

[25] By "isochrones of minimum times" should be understood the lines of chemical composition of those melts from which crystals of equal length (for instance 10μ) are precipitated within the time limits shown on the isochrones. The minimum devitrification time, set forth in Fig. 52, for the formation of crystals of 10μ in length, is valid for any melt of the system at the critical temperature which one may read off from the isotherm diagram as a function of the soda and lime content; at all other temperatures the devitrification time will be longer.

of devitrification, of slowest rate of devitrification (Fig. 52) and of lowest temperature for the maximum rate of growth (Fig. 51) do not absolutely coincide. It is therefore a question of deciding in certain cases, which of these optima is of most importance for the working process under consideration.

In general, devitrification is apt to take place in practice so long as the glass remains in the furnace. If the glass is melted in a tank, where it dwells for a long time, especially

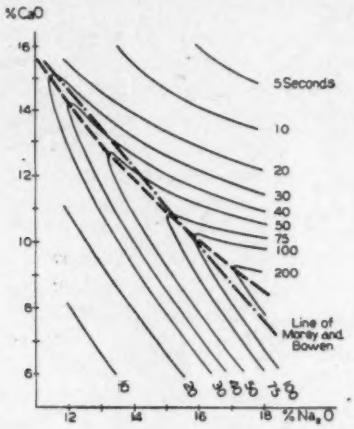


FIG. 52

in corners and back-waters, under unfavorable conditions, the temperature should not fall on any account into the region of under-cooling (i.e., below the upper devitrification limit); otherwise, even with a very low *rate* of devitrification, the long *time* will produce troublesome crystals. In this case it is necessary to pay attention to the isotherm diagram of Morey & Bowen and to locate the most satisfactory composition upon the valley line, which stretches from the point 18% soda 7½% lime to the point 12% soda and 15% lime.

In the working sections of the tank the same requirements in general apply, that is, one should not descend below the temperature of equilibrium between crystal and melt. Such a procedure in many manufacturing processes of the glass industry involves one in difficulties in respect to the working viscosity of the melt. In many cases there is no means of avoiding such a reduction of working temperature as will bring the glass into the region of under-cooling; the conditions are then similar to those of pot-working, as for instance when preparing the glass melt for working out in certain machine processes in special receptacles, such as a trough or floater.

When melting is done in a pot, where the temperature of the whole mass of glass, in the course of the working out process, falls within the region of undercooling, the matter depends mainly upon the position of the temperature of maximum rate of growth and upon the speed of crystallization. In these cases therefore one should decide, with the help of the ridge line of the isochrone diagram of Section 10, the lime-content appropriate to the chosen soda content, and then make an effort to hold the temperature of the melt as much as possible above the temperature of maximum rate of crystal growth as given in the isotherm diagram.

If a sample, taken from the melt after a lengthy working process, is devitrified, the position of the temperature of greatest rate of growth is in general of less significance; the glass cools off to a considerable extent and is again re-heated, so experiencing a greater range of temperature in the under-cooling region. In consequence it cannot be avoided that the glass remains for some time at the temperature of most rapid devitrification. Here it will be advisable to choose, by means of the isochrone diagram, a mix having the slowest rate of crystallization.

In order now to make possible for practical use a rapid determination, independently of the diagram, there are given below certain rules in the form of equations from which it is possible to find the most satisfactory lime-content for a given soda-content in industrial glasses of the soda lime silica series.

Let x be the percentage of soda and y that of the lime, the soda content lying between 12 and 18%, then:—

1. The slowest rate of devitrification occurs when

$$y = 27.7 - \sqrt{62x - x^2 - 422}$$

2. The lowest temperature for the maximum rate of crystallization occurs approximately when

$$y = 23.3 - 0.79x.$$

As a cardinal principle the following approximation will serve

$$y = 26 - x.$$

This appropriation represents an average of the three curves mentioned, including the Morey & Bowen line of most satisfactory upper devitrification limit, and for many practical purposes is sufficient. The matter may be simply expressed thus; The sum of soda and lime shall equal 26% or the silica content shall amount to 74%.[27]

§ 12. Significance of the Extent of the Devitrification Range for Manufacturing Purposes

Whether a given glass behaves for a particular working process (e.g., for cast-plate glass, Fourcault drawing, or tube-drawing on the Danner machine) more or less satisfactorily than another, is a matter which cannot be decided simply on the basis of the temperature of maximum growth-rate and the length of crystal formed at this temperature in a given time; we must also know how wide is the range of temperature within which devitrification of the melts takes place.

For an example we may make use of the curves of the two melts, Nos. 22 and 23 in Section 6. They are set forth in Fig. 53 as functions of the temperature t. Let us suppose that the rate of crystal growth for visible devitrification amounts of 5μ min.,[28] that the upper and lower temperature whereat these limiting speeds of devitrification hold good are at t_2 and t_1, while the maximum crystal growth amounts to v_m. The practical properties of two glasses in respect of devitrification in a given working procedure are then defined by the area $t_2\ v_m\ t_1$; its height is defined by the value of v_m, and its breadth by the temperature interval $t_2 - t_1 = \triangle t$ which may be taken as the temperature-base of the growth curve.

[27] A small content of magnesia (below .5%) can be reckoned simply as an addition to the calcium content; a small content of alumina (under 1%) may be reckoned for practical purposes as so much silica; they have a good rather than a bad influence.

[28] Signifying a limiting length of 1.0μ.

In order to define various glass compositions with respect to their rate of crystallization with absolute completeness it is necessary to give four variables in their relation to the soda and lime content; (1) the temperature of maximum growth; (2) the value thereof (or for glass-works practice, more usefully, the time needed for the formation of crystals

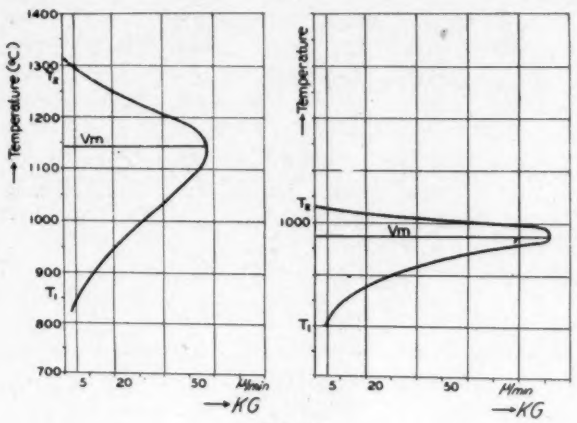


FIG. 53

of limiting length); (3) the upper limit of devitrification; (4) the area of the surface t_2 v_2 t_1. If it is desired to develop the function $v = f(t)$ in the form of an equation one may define as the devitrification surface "F" the definite integral

$$F = \int_{t_1}^{t_2} v \cdot dt$$

wherein for v_{t1} and v_{t2} the limiting values of the crystal growth should be substituted at which the largest crystals precipitated reach a stipulated length (for instance 10 /μ).

Since the mathematical relationship between crystal growth and temperature is not known and since also the limiting rates of growth to be substituted vary with the working process, the devitrification surfaces F were calculated approximately by the aid of Simpson's rule from the growth curves set forth in Section 6, according to the formula:

$$F = h/3\ [y_0 + 4\ (y_1 + y_3 + y_n - 1) + 2\ (y_2 + y_4 + y_n - 2) + y_n]$$

in which h was taken as a 25° interval and y was put equal to the growth in μ/ minute. This gave the following "devitrification-area" in μ ° C.10^{-2}/ Min.

F. 10^{-2}

16%	CaO	37.6	92	140	196
14%		25.6	37	58.4	84
12%		52.8	10.6	13.8	23.6
10%		85.5	25.2	6.2	4.7
8%		146	51.6	9.2	2.3
6%		265	97.4	24.6	10.6
		12%	14%	16%	18% Na_2O

If we now compare glasses of equal devitrification areas on a triaxial diagram of the soda-lime-silica series, we arrive at the curves set out in Fig. 54. The contours of the F value are of a very similar form to those in the isochrone diagram in Fig. 52. From this one may reach this conclusion; as one proceeds along the broken line from the range of the better and more durable melts into the region of glasses of poorer quality, these glasses will continually improve in working properties, while the devitrification surface continually becomes smaller and the glassiness continually greater.

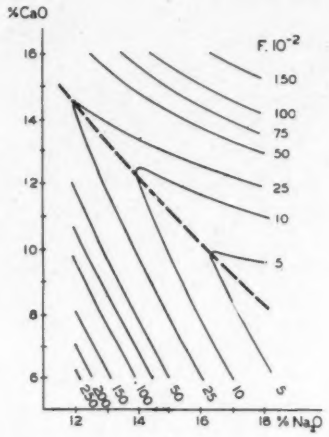


FIG. 54

For glass works practice it might now be useful, instead of making use of the combination of the three diagrams Figures 51, 52 and 54 to use Table 28, from which it is possible to take, for any given soda and lime values, the four variables defining the behavior of the glass:

1. Temperature of Maximum Growth-rate (°C).
2. The time in seconds for the growth of crystals of equal length.
3. The devitrification surfaces F.
4. The upper devitrification limit in °C according to Morey & Bowen.

TABLE XXVIII.

CaO						
16%	(1)	990	1000	1000	1005	°C.
	(2)	17	9	5	3	seconds
	(3)	=38=	=92=	=140=	=196=	"F"
	(4)	(1110)	(1015)	(1080)	(1060)	°C.
14%	(1)	975	980	980	985	
	(2)	40	19	9.5	7.5	
	(3)	=26=	=37=	=58=	=84=	
	(4)	(1150)	(1055)	(1040)	(1025)	
12%	(1)	1080	945	930	950	
	(2)	24	48	32	21	
	(3)	=53=	=48=	=32=	=21=	
	(4)	(1225)	(1055)	(995)	(990)	
10%	(1)	1125	1050	910	900	
	(2)	16	40	85	55	
	(3)	=85=	=25=	=6=	=5=	
	(4)	(1265)	(1155)	(975)	(955)	
8%	(1)	1140	1100	1005	875	
	(2)	11	19	55	200	
	(3)	=146=	=52=	=9=	=2=	
	(4)	(1320)	(1200)	(1100)	(925)	
6%	(1)	1170	1125	1060	910	
	(2)	7.5	12	24	75	
	(3)	=265=	=97=	=24=	=10=	
	(4)	(1360)	(1250)	(1160)	(1010)	
		12%	14%	16%	18%	Na_2O

Summary

1. For investigating the rate of crystallization in the technical soda-lime-silica glasses 24 melts were investigated

whose compositions varied in steps of 2% between the points 6% CaO 12% Na_2O up to 16% CaO 12% Na_2O.

CaO 6%	→ by 2 %	CaO 16%
Na_2O 12% by 2% ↓		CaO 12% ↓ by 2%
CaO 16%	→ by 2%	CaO 6%
Na_2O 18%		Na_2O 18%

The glasses were melted in the laboratory in a platinum crucible, using pure raw materials, and were made homogeneous by a single re-melting. In making the mixtures the loss of soda was compensated for by adding an extra .25% of Na_2O. All melts were analyzed.

2. By means of the method described in the former work the rate of devitrification was determined for each glass at various temperatures. Among those glasses which precipitate two compounds the growth curves were as far as possible determined for each crystal phase. Since these curves in part overlap each other, it is the enclosing outer curve which constitutes the practical measure of devitrification, independently of which phase this may represent, as it gives the greatest rate of crystal growth when one phase overlaps the other.

3. The precipitated compounds were in most cases cristobalite and wollastonite; in less important degree, tridymite, pseudo-wollastonite and the double silicate Na_2O, 3 CaO, 6 SiO_2; the last was found only by X-ray analysis, the remainder could be identified under the microscope.

4. In order to determine the influence of thermal history upon the rate of crystal growth a glass from the territory of the compound Na_2O, 3CaO, 6SiO_2 was melted at various temperatures and according to several methods. All these melts on devitrifying produced the same compounds, namely, cristobalite and wollastonite, and at practically the same rate.

5. A connection between viscosity and the curve of growth was pointed out. The temperature above which these samples, in the time allowed for devitrification, altered their external shape, coincides for the most part with the lower limit of devitrification, i.e., with that temperature above which the rate of growth takes on significant values. According to the diagram of Washburn & Shelton the viscosity at this temperature amounts to about 10^5 Poises. Further it is noteworthy that among the lime-rich "short" glasses the curve of crystal growth takes a sudden curve in accordance with the sudden change of viscosity and thus produces a peak, while among the silica-rich or "long" glasses the course of the growth-curve is much smoother.

6. The growth-curves of the various glasses were combined in a diagram of Zschimmer's four-dimensional type, wherefrom the influence of composition upon rate of growth may be seen. In soda-rich glasses containing for instance 18% Na_2O, lime up to about 8% affects the glassiness favorably; with higher lime-content the devitrification increases rapidly. On the contrary, in the soda-poor glasses containing say 12% Na_2O, lime behaves satisfactorily up to about 12%.

7. From the discontinuous four-dimensional diagram two other diagrams were constructed which set forth in continuous fashion the two constants of devitrification as functions of chemical composition. These two constants are, the temperatures of the maximum rate of growth, constituting the isotherms, and the shortest times of devitrification for the production of a given length of crystal (10μ), constituting the isochrones. If one pictures the isotherm diagram in a broad fashion, there is seen a valley from the point 18% Na_2O, 9% CaO to the point 12% Na_2O, 13.7% CaO; upon this line lie the glass compositions at which the maximum rate of growth is at a minimum as compared with that of neighboring compositions. If we write x for the percentage of soda and y for the lime content the empirical equation of this line is $y = 23.3 - 0.79\ x$. In a similar way a ridge line is found on the isochrone diagram; upon this line those compositions which correspond to glasses which crystallize most slowly. This line of greatest glassiness has therefore particular practical significance. It corresponds with the equation

$$y = 27.7 - \sqrt{62\ x - x^2 - 422}$$

The two lines do not exactly coincide but cut one another at an acute angle. The trace of the ridge line on the isochrone diagram approximates quite closely to the trace of the valley line from the isotherm diagram of Morey and Bowen.

As an approximate form, the equation of a straight line was given which constitutes a fair mean of the three given curves, namely, y (% CaO) = 26 — x % Na_2O, which may also be expressed; the soda and lime content among technical soda-lime-silica glasses should total 26%.

8. For practical purposes it boils down to a question as to which optimum in any particular case is to be chosen. It was pointed out that in the melting end of a tank one must not drop below the upper devitrification temperature, and in consequence the diagram of Morey & Bowen is the complete answer to the question. In the working end of the tank and for pot furnaces, with longer working processes, one chooses, as objective, if a descent below this temperature cannot be avoided, such a glass composition as lies upon the ridge line of the isochrone diagram, and departs as far as possible from the temperature of maximum growth rate indicated in the isotherm diagram.

9. For many working processes not only is the temperature of the maximum rate of growth and the absolute value of this growth of importance but the question also arises, how wide the practical range of devitrification temperature really is. It is also of importance in comparing two glasses with respect of devitrification to note the "devitrification-area" which is enclosed within the growth curve, between its intersections with a given limiting rate of growth. These areas, thus enclosed between the growth curve and the ordinates in question, were calculated by Simpson's rule and set forth in a diagram; this diagram has very much the appearance and properties of the isochrone diagram.

European Glass Production

From *Glastechnische Gesellschaft*. Production capacity in drawn glass in the leading glass-making countries of Europe per annum (in millions of square metres): Belgium, 59.7; Germany, 22.2; Czechoslovakia, 19.5; France, 19.2; Russia, 15; Italy, 6.6; Great Britain, 4.2; all other countries, 13.8.

Glass or Not Glass?

EFFORTS to find a satisfactory definition of the term *glass* have failed in the past, and we are now threatened with confusion worse confounded by the tendency of inventors to claim as "glasses" certain polymerised resins and other organic materials. The question whether such an appellation is legitimate or not may come up for consideration in an acute form one of these days, and we would like to take the opinion of our readers as to what materials are properly called glasses in a technical, industrial, or popular sense. Is it proper, for instance, in such a publication as a newspaper, to describe as a new "glass" a material more or less allied to bakelite?

In a scientific sense, it may be argued that any non-crystalline material in the solid form is a glass, if it has no obvious structure. We might for instance exclude fibrous materials, such as wood, but we might have difficulty in excluding, on strictly scientific grounds, pockets of resin or resinous exudations from the wood. The fact that these resins are usually more or less fluid as found, would not of itself exclude them, for there is no inconsistency in the term "molten glass," so that we cannot insist on solidity as an essential qualification. Further, fossil resins, such as copal, are solid. Is copal entitled to be called a glass?

Is natural amber a glass?

We cannot insist on glass being an artificial product, for many volcanic rocks contain uncrystallized silicates and are known as natural glasses.

The dictionary seems disposed to regard as legitimate glasses only those substances that are essentially fused silicates, but accords a somewhat grudging recognition to other substances "resembling glass." We are inclined to follow the dictionary, and consider that from an industrial point of view, a material is not technically a "glass" unless it contains an appreciable proportion of silica, and that in a more or less amorphous form. This definition would admit straight silica-glass (fused silica), and the whole gamut of the soda-lime, potash-lead, barium crown and other optical glasses, as well as the opals and alabaster glasses, and other silicate products transparent or not. It would not exclude glasses containing crystalline elements, such as the opals, provided that much of the silica were in the uncrystallized condition. On the other hand it might admit to the rank of glasses certain materials that are more nearly like clays.

From the point of view of the industry, the essence of glass making seems to be the employment of high temperatures and the use of silicates, usually sand. These factors characterize the industry, and give it such coherence and homogeneity as it possesses, and while we welcome the advent of calcium phosphate glasses and beryllium borates, and the striking developments of organic substances resembling glass in some particulars, yet we think it not altogether satisfactory to describe these in the vernacular press without a warning that they are not glasses in the industrial sense. A similar proceeding in the metal field would result in monel metal being described as a new steel.

However, we are open to change our opinions if our readers feel that they are out of date. We do not necessarily feel compelled to cling to definitions that would have satisfied the ancient Phoenicians.

A question recently directed to several well-known authorities and writers on glass as to the propriety of using the term glass as descriptive of certain organic substances, disclosed considerable difference of opinion on the subject but the consensus was that it is undesirable to use the simple word glass to describe materials other than silicates.

Professor Alexander Silverman, Head of the Department of Chemistry. The University of Pittsburgh, has stated that he prefers to class solid, transparent, organic plastics as glass substitutes. "One," he says, "is not inclined to call the diamond a glass because it is transparent and certainly its hardness is greater than that of any organic substitute or even of glass itself. Transparent fused quartz is referred to specifically by name and not as glass. Why then should organic compositions which resemble glass in appearance be called glass?"

With this comment we print below from the Pittsburgh *Sun-Telegraph* a notice of an interesting new organic substance produced at the Mellon Institute, Pittsburgh, said substance to be a glass or not according to our readers' viewpoint.

> "Mellon Institute announced another miracle of science—the making of glass from natural gas. The material has been given the name 'vinylite.'
>
> "Dr. W. A. Hamor, assistant director, showed various samples of the product—a large cylindrical mass looking like a cake of ice, a sheet of it, and beautifully-tinted ornamental boxes molded out of the material.
>
> "Though it looks like glass and has valuable properties that ordinary glass lacks—for instance, it is not fragile, and does not stop the ultra-violet rays of the sun—vinylite, it was said, is hardly likely to be used in windows because it does not weather well.
>
> "One of its chief uses will be as a plate or coating for metal and other materials. Dr. Hamor remarked that metal containers were not to be recommended for sour kraut because the acetic acid in the kraut would corrode the metal. But if the container is coated with vinylite it may be used for kraut, the vinylite not being affected by acetic acid.
>
> "Vinylite is produced in this way: Ethane, a gaseous constituent of natural gas, is extracted by a process devised by Mellon Institute, passed through a red-hot tube, and thereby transformed into a gas called ethylene. The ethylene is treated with sulphuric acid and transformed into an ester which, mixed with water, gives vinyl alcohol, along with other products. The vinyl alcohol is treated with hydrochloric or acetic acid and is then easily converted into a vinyl resin.
>
> "Thus," said Dr. Hamor, in detailing the process, "an organic glass, a solid substance of unique properties and commercial promise, is made from natural gas.'
>
> "Dr. Hamor added that 20 other substances have been derived from natural gas and are finding big markets in the industries.
>
> "The process by which vinylite is produced was developed by Ernest W. Reid, R. B. Frazier and co-workers in a multiple industrial fellowship on organic synthesis at Mellon Institute."

—F. W. P.

Glass Industry

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Unwritten Epics

We are informed by Longfellow—and he ought to know—that at one time Hiawatha was sadly distressed by the lack of any adequate record of the doings of great men.

> "Lo how all things fade and perish!
> From the memory of the old men
> Fade away the great traditions!"

And after some cogitation, Hiawatha invented picture-writing.

The glass industry is in the same unfortunate situation but a Hiawatha has not yet come to its rescue. Plants arise decay, and are abandoned. The stream of inventions flows so rapidly that none can keep track of its progress. Some dispute has even arisen as to who actually made Edison's first electric lamp-bulb.

It is not so many years since the first successful machine for making bulbs was invented; it is now in the Smithsonian Institute, a museum relic. Other relics are less fortunate.

In other branches of industry the stream of progress has left the wreckage of a hundred comely inventions on its uncompromising shore, and little record remains of them. The patents office records tell of many ships that never came home, but their careers are not recorded, the rocks and shallows they encountered are not charted, and even the craft themselves are described in terms that few can recognize as relating to the inventions in question.

Along with the inventions go the inventors. Our generation is witnessing the passing of the first great school of master mariners, men who in a few years changed the art of antiquity more than it had changed in a millenium. Yet where are their biographies? Are our faces so set toward the future that we cannot spare a few hours, a few pages, to recording the present and recent past while it is yet possible?

It is only recently that any interest has been taken in the history of science or of industry. Yet that interest is developing rapidly. In a few years our children will demand the records of our fathers' work, and we shall have nothing to offer them but the sad gibberish of obscurantist patent specifications, the very incomplete series of specimens in the Smithsonian Institute and the Science Museum, and the hearsay of our failing recollections. They shall ask a loaf, and we must give them a stone.

When Napoleon was carrying on his frantic campaigns all over Europe, the steamboat was invented, and—to his shame be it said—Fulton offered his version of it to Napoleon for the invasion of England. Fortunately Napoleon could not see the point. Probably that fact is of more importance than all the other points in the great Corsican's career, though poor school children are put to some pains to learn about military campaigns whose effect is of infinitely less importance than the coming of the steamboat.

Is it not possible that the coming of the electric lamp bulb, the radio "tube," and other examples of the glassmakers' art, may prove of more importance in the long run than the coming of the steamboat?

And who is going to write the Epic? Has not the time come for the formation of an Industrial History Society, with sections devoted to each craft and art?—*F. W. P.*

Benedictus Patent Infringement Decision

Sustained by U. S. Circuit Court of Appeals

THE validity of Benedictus patent No. U. S. 1,182,739 dated May 9, 1916 was upheld July 16 by decision of the United States Circuit Court of Appeals at Philadelphia, Pa. The opinion upheld the decision of Judge F. B. Schoonmaker filed on November 15 in the Federal Court at Pittsburgh in the case of the Triplex Safety Glass Company of North America against the Duplate Corporation, formerly known as the Pittsburgh Safety Glass Company.

Before Judges Buffington and Davis, circuit judges in the U. S. Circuit Court of Appeals for the Third Circuit, and Judge Johnson District Judge, the decision of the District Court of the U. S. for Western Pennsylvania in the patent infringement case of Triplex Safety Glass Company of North America versus the Duplate Corporation (formerly Pittsburgh Safety Glass Company), was sustained and Benedictus U. S. Patent No. 1,182,739 applied for June 14, 1911, and dated May 9, 1916, declared valid.

The body of the decree, filed July 16, 1930 is quoted in full, as follows:

Buffington, Circuit Judge.

This case concerns a glass which is non-shatterable in that while it may be broken, the broken pieces stay in place and will not splinter. It is largely used in automobiles and since, as stated by the Court below, sixty per cent of automobile personal injuries are caused by flying splinters, not only its commercial value will be seen, but if protected by a patent, such patent partakes of the humane. See 159 Fed. Rep. 135, where this Court in an analogous situation said: "He contributed to an important industry a device, . . . which . . . rose to the plane of the humane." Fragility is inseparable in the mind with glass and to apply to it the word and quality, non-shatterable, is to suggest at once novelty, originality, pioneership. And such is the case. On January 11, 1910, Benedictus, a French artistic painter, applied for and was granted Patent No. 1,098,342 for "reinforced glass and process of manufacturing the same." In his specification he states:

> "This invention relates to the application of sheet celluloid for strengthening or backing glass and it has reference more particularly to a product formed of two sheets of glass united by the interposition and sticking or pasting between them of a sheet of celluloid."

He aptly summarizes the distinctive features of his glass in his first claim, which reads as follows:

> "As a new article of manufacture laminated, adherent sheets of glass and flexible celluloid, the surface of the celluloid firmly adhering to the glass whereby a composite is provided having substantially the transparency of glass, the adhesion and strength of the celluloid being such as to reinforce the structure, resist rupture and prevent the scattering of glass fragments on the breakage of the glass."

Benedictus glass was called to the attention of some people in London, who were led to form a company, buy his patent and begin making Benedictus glass. The company also bought a later Benedictus patent, to which reference will be hereafter made, an which is the patent in suit. The English company made glass under the two patents and sold them to the Triplex Safety Glass Company of North America, the plaintiff in the present case. The proof is that while Benedictus' first patent was practical and produced a non-shatterable glass, that it was not wholly satisfactory because "we did not get adhesion to any measurable degree." The company experimented to get better adhesion. "We endeavored to use Canada Balsam as an adhesive, but the results were not satisfactory. We attempted to use castor oil, with unsatisfactory results." Attempts were made to soften the faces of the celluloid before applying heat and pressure—many plastic solvents of celluloid were tried but without success.

In this state of the art Benedictus in his patent No. 1,182,739, applied for June 14, 1911, and granted May 9, 1916, disclosed a solution of the difficulty, in the new article of manufacture, which is the bone of contention in this case. Such new article of manufacture is aptly described in his twelfth claim, which is hereafter stated and which alone is in issue in this case. His other eleven claims, with which we are not here concerned, show methods he disclosed of making his new glass. Briefly stated, Benedictus' disclosure was the use of gelatin substantially free from contained moisture. Coupling his later with his earlier efforts, Benedictus says in his specification:

> "This invention relates to a new process for the manufacture of the strengthened glass which forms the subject of my application for Letters Patent filed January 11th, 1910, Serial No. 537,557, and my application for Letters Patent filed June 13, 1911, Serial No. 632,850."

Describing gelatin as being effective as an adhesive but objectionable on account of its hygroscopic or moisture retaining characteristic, his specification says:

> "This process relates more particularly to the case of a strengthening layer composed wholly or in part of gelatin. Gelatin, which liquefies at a comparatively low temperature, presents the advantage of being readily attachable to glass or celluloid under the action of *moderate heat* completed if necessary by the application of pressure and without requiring the use of a solvent to soften the surfaces which are to be stuck together. Nevertheless gelatin is a hygroscopic substance which *in spite* of attempted drying may easily retain moisture which prejudicially affects the solidity and the transparency of the finished strengthened glass."

The specification then discloses details of means by which Benedictus showed, in accordance with the statute requirement, how the objectionable moisture of gelatin could be removed and which suggested processes are embodied in his first eleven claims. On this specification he was allowed Claim 12 which divided into its constituent elements is:

A. His new product "As a new article of manufacture."

B. Its constituent elements "a sheet of celluloid faced on both sides and in the order named by sheets of gelatin and glass."

C. How treated "all rigidly and autogenously united together."

D. The essential characteristic of the gelatin. "The gelatin being substantially free from contained moisture." In its entirety the claim reads as follows:

> "12. As a new article of manufacture, a sheet of celluloid faced on both sides and in the order named by sheets of gelatin and glass, all rigidly and autogenously united together, and the gelatin being substantially free from contained moisture, as described."

It will be noted that the novel element in the new article of manufacture so therein claimed was sheets of gelatin substantially free from contained moisture and not the mode of making such sheets which was the subject of the eleven process claims. That such new article was novel appears from the proofs. The patent of Wood, No. 830,398, did not disclose the combining and conjoint use of all the elements of Benedictus' claim and moreover where he suggested the alternative use of either "a sheet of celluloid between two sheets of glass" or "of a film of gelatin or other transparent substance less brittle than glass," Wood used Canada balsam, which as we have seen proved unsatisfactory. Moreover the proof by a witness who took part in the starting and development of non-shatterable glass in England is: "I never met Wood, or anybody manufacturing under Wood, in competition in England."

That the glass was useful is shown by the use made of it and the rapid and broadening market it brought into being on its own merit.

> "The plaintiff company started to manufacture in 1926, and during that year shipped 1,153 square feet; in 1927, approximately 50,000 square feet; in 1928, approximately 2,000,000 square feet and in the first six months of 1929, about 3,750,000 square feet."

In addition to this market under the patent, there was a large infringing use by the defendants for the proof is:

> "In 1928 this defendant began to make competition with our company felt; this competition had a very decided effect upon our prices."

Moreover the evidence is that in addition to the makers recited above, there was a licensed product made by large users. In that regard the proof is:

> "At the initiation of our business we had considerable difficulty in introducing the product upon the market. We went to the automobile manufacturers, and they all took the position that, irrespective of the merits of the product, they would not put it on the cars that they manufactured until the public demanded it; and we were forced to sell to individuals until we

could create a popular demand for the product, although we were able to demonstrate the fact that two-thirds of the people that were injured in automobile accidents in this country were hurt by the glass. This was the result of our investigation through the insurance companies.

"We sold a license under the patent in suit to the Ford Automobile Company in 1927, on a basis by which they could manufacture Triplex in return for a contract by which they agreed to buy not less than half of their requirements from us. The license provided that they could manufacture Triplex up to half of their requirements for vehicles produced by the Ford Company and its subsidiaries. This year we sold a license to the Johnson Glass Company of Hartford City, Indiana, in return for an agreement to pay us ten cents a square foot royalty on the glass they sold, or five per cent of the sales price, whichever was the greater, and they in turn agreed not to sell any glass below the prices we were selling at, and limited the amount they could make to ten per cent of our production. The product of these licensees is the same as ours."

We are therefore led to the conclusion that the patent is valid. In that regard and in its meritorious character and in the fact that the defendants infringe, we find ourselves in accord with the trial judge as stated in his opinion in language and reasoning we could not improve upon:

"We have no hesitation in concluding that the patent is valid, that there was a real invention in bringing to the art the product made by adhesion of celluloid and glass with the use of gelatin that is substantially free from contained moisture. It was thoroughly demonstrated that using wet gelatin or sticky gelatin for the purpose of cementing together the sheets of glass and celluloid resulted in a product which was streaked and cloudy, took away from the clear visibility that was produced by the use of gelatin from which the moisture had been substantially substracted. The use of this dehydrated gelatin as a cement was not mere improvement in a crowded art. Benedictus was the first to bring to the art the use of gelatinous cement which would provide an unclouded glass. We, therefore, hold his claim 12 valid, and construe it broadly as bringing to the art a new product, i. e., laminated glass, in which the constituent elements of celluloid and glass have been cemented together with a gelatin which has been substantially dehydrated.

"We need next to determine whether or not the defendant by its product has infringed the patent. We find from the evidence that the defendant in its product uses glass and celluloid cemented together by a thin film of gelatin in substantially the same manner as that disclosed by the Benedictus patent. In other words, the defendant uses for cement a gelatin from which the moisture has been substantially extracted by heat. That was the main disclosure of the Benedictus patent, i. e., the fact that gelatin which is practically dry to sight and to touch could be used under heat and pressure so as to cause sheets of glass and celluloid to adhere and thus produce a strengthened glass with no impairment of transparency. That was the real invention of Benedictus.

"The defendant has incorporated in its product that very element. There is evidence that the moisture-content of the gelatin used by the defendant is much greater than the gelatin used by the plaintiff's process, and that the defendant in its process does not use alcohol to further the dehydration of the gelatin. But the main element is there—gelatin with the moisture sufficiently extracted so as to cause the sheets of celluloid and glass to adhere to one another with no impairment of transparency. That is the product of both processes used by the plaintiff and the defendant."

So holding the decree below is affirmed.

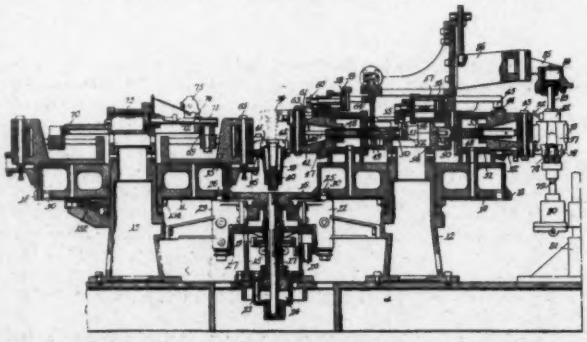
Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

APPARATUS FOR BLOWING THIN-WALL GLASSWARE. U. S. 1,766,135. June 24, 1930. James W. Lynch, Anderson, Ind., assignor to Lynch Glass Machine Company. Filed 8/28/30.

In a glass ware forming machine of the character described, the combination of movable blank and blow molds, the blank molds comprising separable mating body and neck portions, adapted to receive the sheared gather and initially form the blank in inverted position and the blow molds comprising a seamless body and separable mating neck or "bust-off" portions, means for moving said molds to successive operating stations including a transfer station, means for automatically disengaging the body portion of the parison mold from said parison at the transfer station, thereby



to suspend the parison by the neck portions, means for moving the blow mold into cooperative position with respect to the suspended parison at the transfer station, and means to disengage the neck portion of the parison mold from the parison to permit it to be received by the blow mold.

GLASS-FABRICATING MECHANISM. U. S. 1,753,655. Apr. 8, 1930. Everett O. Hiller, Hartford, Conn., assignor to Hartford-Empire Company. Filed 1/3/28. An invention to provide means for positioning non-circular glass articles while they are still associated with the molds in which they are formed by turning the bottle on its vertical axis while it is still in the mold and after the mold is opened, preferably by rotating the bottom plate of the mold so that when they are removed from the molds and conveyed to an annealing lehr, they may be stacked therein with the maximum economy of space upon the lehr conveyor, and preferably also upon any conveyor which may be used in transporting them from the forming machine to the lehr.

PROCESS FOR PRODUCING LAMINATED GLASS. U. S. 1,761,770. June 3, 1930. Wilbur F. Brown, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 1/21/28. An object of the invention is to provide a process and apparatus for producing laminated glass wherein a sheet of non-brittle material is united to two sheets of glass and the process contemplates the making of the laminated sheet over sized with respect to the sheets of glass, so that a suitable clamping means may be associated with the non-brittle sheet during the uniting of the laminations to prevent slippage of the non-brittle sheets with respect to the glass sheets.

A further object includes clamping means adapted for engagement with the non-brittle sheet during the pressing of the laminations together, said clamping means being so constructed and so mounted that the laminations may be pressed together in a suitable press and the clamping means will not interfere with the uniting of the laminations but will prevent relative movement therebetween.

LAMINATED GLASS. U. S. 1,753,744. Apr. 8, 1930. Frank Fraser, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 8/23/26. An invention to provide the process wherein a skin formed from vegetable oil is deposited on a sheet of glass, after which the sheet of glass and a sheet of non-brittle material are united by preferably applying some suitable liquid between the two, and then subjecting the same to the action of heat and pressure.

SHEET-GLASS EDGE-FORMING MEANS. U. S. 1,753,749. Apr. 8, 1930. Leopold Mambourg, Lancaster, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 5/29/25. An invention to provide a sheet glass drawing apparatus, and means for guiding the edges of the sheet being drawn in a manner to create a beaded edge and to hold the beaded edge past a point where the edge will be sufficiently strong to overcome the natural tendencies of the sheet to contract or narrow.

The Glass World and What It Is Doing

News of the Industry

Libbey-Owens-Ford Income and Expense

	For the Three Months Ended June 30, 1930	For the Nine Months Ended June 30, 1930
MANUFACTURING PROFIT after deducting Materials Used, Labor and Mfg. Expense	$1,238,197.96	$4,047,566.96
Less: Depreciation	368,333.73	1,044,520.46
NET MANUFACTURING PROFIT	$ 869,864.23	$3,003,046.50
OTHER INCOME	30,289.36	151,013.11
TOTAL INCOME	$ 900,153.59	$3,154,059.61
OTHER DEDUCTIONS: Administrative, Selling, Patent, Interest, Experimental & Development Expense, Provision for Doubtful Accounts, Contingencies, Etc.	467,777.35	1,244,164.12
PROFIT BEFORE PROVIDING FOR FEDERAL INCOME TAX	$ 432,376.24	$1,909,895.49
PROVISION FOR ESTIMATED FEDERAL INCOME TAX	52,000.00	230,000.00
NET PROFIT	$ 380,376.24	$1,679,895.49

On July 22, 1930, the Board of Directors declared the regular quarterly dividend of Twenty-five Cents (25c) per share, payable September 1, 1930, to holders of record at three o'clock P. M., August 15, 1930.

Flint Glass Workers Visit Toronto

At the twenty-eighth annual meeting of the American Flint Glass Workers' Union held at the Royal York Hotel, Toronto, Ontario, July 11, William P. Clark was re-elected president, M. J. Gillooly vice-president, C. J. Shipman, secretary and treasurer, H. H. Cook, assistant secretary. All of these officers are situated in Toledo. Joseph O'Malley of Fostoria, Arthur Elbert of Huntington, Thomas J. Gallagher, Pittsburgh, were re-elected national organizers. M. J. Billz was appointed delegate to the American Federation of Labor meeting at Boston in October. The city of Morgantown, W. Va., won the contest for the convention meeting in 1931.

January to June Construction Shows Small Decline

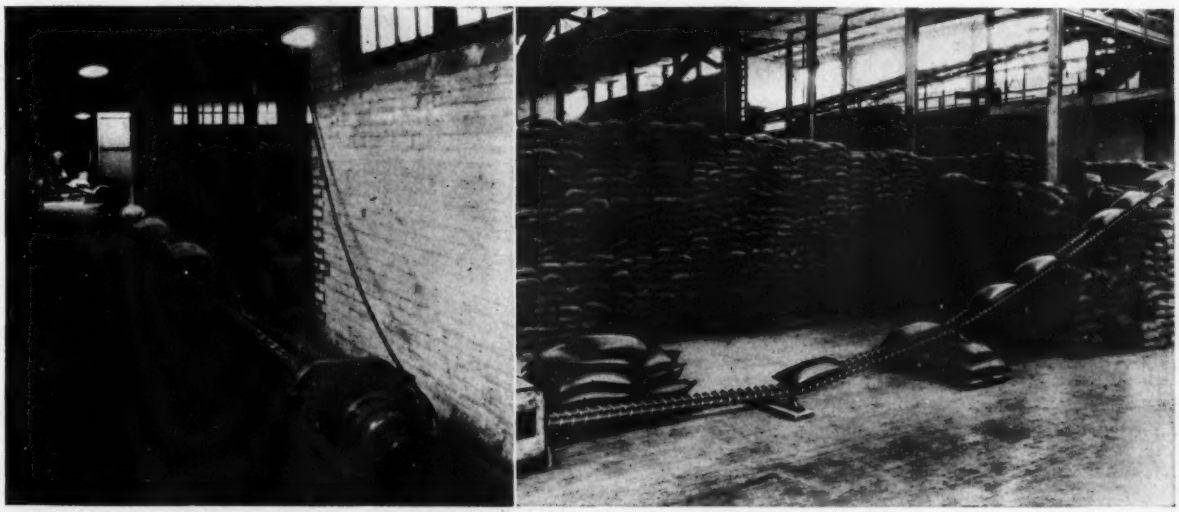
June contracts let for new building and engineering works in the 37 states east of the Rocky Mountains amounted to $600,573,400 according to F. W. Dodge Corporation. The past month's record was substantially larger than the total of $457,416,000 for the previous month; showed a good gain over the total of $529,891,100 for June, 1929; and was the largest monthly total since July, 1929. For the first half of 1930 construction contracts aggregated $2,638,013,300. This was a decline of only 12½ per cent from the total of $3,015,546,800 for the corresponding period of 1929. At the end of May contracts for the year to date were 18 per cent behind last year.

Still Receiving Congratulations

Much interest has been manifested especially in the bottle trade, in the recent election of L. S. Cunningham of D. O. Cunningham Glass Company, Pittsburgh, to the presidency of the Glass Container Association of America. Mr. Cunningham succeeds Philip I. Heuisler of the Maryland Glass Company, Baltimore, Md., who desired to be relieved of the burdens of the office and whose resignation had been received. The election took place at a meeting of the Board of directors of the Association in New York on July 9.

Donald Sharp Goes to Europe

Donald E. Sharp, President of Bailey & Sharp Co., glass engineers and technologists, and a member of the staff of THE GLASS INDUSTRY, left for a trip to Germany, England and France on July 5. He expects to call on a number of foreign manufacturers of glass and machinery. He was accompanied by his wife, and expects to return about the middle of August.



HERE IS THE LATEST "WRINKLE" IN CONVEYING AND ELEVATING EQUIPMENT. THE "TWINVEYOR," JUST BROUGHT OUT FOR THE CLARK TRUCTRACTOR COMPANY BY R. MARSHALL, 6553 WOODWARD AVENUE, DETROIT, MICH.

Time to Get Ready for Ceramic Exposition

Only a few months remain before the opening of the second American Ceramic Congress, including the American Ceramic Exposition, at the Public Auditorium, Cleveland, Ohio, February 23-27, inclusive, 1931. Elaborate preparations are being made both for the technical meetings and the exhibition. Producers of glass and ceramic wares and manufacturers and distributors of glassmaking and ceramic equipment and supplies who intend to be adequately represented at the Exposition should be sending in their applications for space and making arrangements to provide attractive displays.

The products to be exhibited will be classified according to their kind. Classification No. 1 includes glass, enamel and pottery products. The glass section will include oven, art, novelty, table, plate, window, ultraviolet glass and lighting fixtures. Refractories, enamel and pottery products also come under classification No. 1 and include the many varieties that will be exhibited. Classification No. 2 includes processing machinery, raw materials, power and power transmission equipment, dryers and lehrs, furnaces and kilns, control devices, fans and pumps, material handling equipment, etc. Full information regarding the costs of space, etc. may be obtained from W. H. Eisenman, manager of the American Ceramic Exposition, 7016 Euclid Avenue, Cleveland, Ohio.

Six Months' Production Polished Plate Glass

The production of Polished Plate Glass in the United States for the month of June, 1930, was 9,128,216 sq. ft., as compared with 12,278,002 sq. ft. produced in the corresponding month last year, June, 1929. This makes the total production for the first six months of 1930, 66,367,375 sq. ft., as compared with 73,474,143 sq. ft. produced in the same period last year.

Edward Miller Returns from Europe

Edward Miller, proprietor of Miller Machine & Mold Works, 705 Ann Street, Columbus, Ohio, returned on July 3 after spending 10 weeks in Europe. Mr. Miller combined business and pleasure and found conditions very encouraging in the factories that he visited.

A Correction

It has been recently disclosed by a writer in the *Journal of the Society of Glass Technology, England* that an error appeared in an article in the November, 1929, issue of The GLASS INDUSTRY. The article is entitled "Chemism of Melting of Soda-Boro-Silicate Glass," by M. A. Besborodov and M. F. Shoor. On page 258 in the second paragraph of Part II, the composition of the batch used for experimental purposes contained the item, boric acid 14.28 parts. This was a misprint. The figures should read, boric acid 44.28.

Trade Activities

Howe Glass Company, Inc., Plainfield, N. J., has obtained a charter to manufacture glass, etc. Capital, $30,000.

The Weston Glass Company, Weston, W. Va., closed down for repairs to tanks and will reopen, it is expected, the latter part of August.

D. C. Jenkins Glass Company, Kokomo, Ind., recently closed down their Arcadia factory for two weeks for repairs and a general overhauling of the plant.

The Capstan Glass Company's new carton factory at South Connellsville, Pa., will be ready for operation very shortly. It is reported that about 50 men will be permanently employed.

The Ford Motor Company's Glassmere, Pa., plant which closed down July 11 for repairs was expected to resume operations before the first of August.

H. D. Traver, who for several years had been associated with the Plate Glass Manufacturers of America, died at his home in Cleveland, O., on July 4.

The Erskine Glass & Manufacturing Company, Wellsburg, W. Va., at their annual meeting July 15, 1930, reported a very satisfactory year's business and re-elected the present officers.

Harshaw Chemical Company announces the opening of offices at St. Louis, Mo., with Robert Galbraith, sales manager, in charge at 4908 Delmar Boulevard.

The Cameron Glass Company, Cameron, W. Va., report having resumed operations on their chimney shops after a shut-down for tank and other repairs. Under normal conditions the company employs about fifty or more men.

The Ford Motor Company's pot glass plant at Glassmere, Pa., is reported to have resumed operations after a shut-down of two weeks' duration for repairs. Upon reopening it is said that 40% of the working force was reemployed.

The Pittsburgh Plate Glass Company a few weeks ago was reported in local newspapers of Detroit River towns to be investigating the desirability of locating a new plate glass manufacturing plant in that territory. No confirmation of the report was available.

The Scohy Sheet Glass Company, Sistersville, W. Va., according to a dispatch from Middlebourne, W. Va., had all of its production records broken by shift No. 3 on Saturday, July 5. This accomplishment was not deliberately planned but was revealed at the check-up of the day's work.

The Marienville Glass Company are erecting a new building to replace their plant destroyed by fire. The new structure is in the hands of the Clarion Box Company. It will be finished early in August. The same company is building a new office building at Parker, for the Wightman Glass Bottle Company.

The State Department of Commerce, West Virginia, recently issued a report on exports from the State for the year 1929, showing a total drop of approximately $2,000,000 below the total for 1928. Exports of glass and glass products, however, are given as $1,000,053 for 1929 compared with $865,544 in 1928.

The Pittsburgh Plate Glass Company's plant at Kokomo, Ind., which recently discontinued manufacturing operations, reopened some of the departments in June for a limited period, principally for grinding, polishing, etc., and for completing unfinished products which the company had in stock.

The Pittsburgh Plate Glass Company's plant at Ford City, Pa., is putting a new roof on works No. 5. Work is said to be progressing rapidly on reconstruction of the interior of the factory in anticipation of the installation of equipment from the dismantled Charleroi plant.

The United States Glass Company, Pittsburgh, Pa., report changes in their organization: President E. E. Slick has resigned to become chairman of the board, C. T. Mahan was made president, and W. R. Nickel re-elected secretary and treasurer. Mr. Mahan was formerly connected with the Shreveport plant of the Libbey-Owens Sheet Glass Company.

United Sash & Door Glass Company, Tucson, Arizona, will shortly begin operations in its new plant. It is said that the investment involved in buildings, stock and equipment approximates $100,000 outside capital brought into Tucson. The payroll it is said will average $300,000 a month. W. A. Ley of Phoenix, who has been in a similar business in that city, is manager.

The Libbey-Owens-Ford Glass Company, Nicholas Building, Toledo, Ohio on June 30 issued a formal notice officially confirming the fact that on July 1 the company had acquired the entire assets and good will of the Edward Ford Plate Glass Company of Rossford, Ohio. Also that the company's name had been changed as above and that all communications by mail, telegraph, or telephone should be addressed to the above office. The telephone number is Main 5291.

The International Filter Co. and its associated companies, International Water Softener Co. and General Zeolite Co., builders of water softening and filtration plants, announce that expansion of their manufacturing facilities required the removal of their general offices and engineering departments from plant No. 1 at 333 West 25 Place, Chicago, to larger quarters in the Buckingham Building, 59 E. Van Buren Street, Chicago, Ill.

Buffalo Forge Company, Buffalo, N. Y., E. Lynn Hubbard, assistant advertising manager, recently issued a circular on their Twin Breezo-Fin Unit Heater. A rating table is given for different R.P.M. and steam pressure from 5 to 40 pounds. A feature of this device is the combination of two 16 inch fans with the aerofin heating coil.

Frank S. Cunningham, president of Butler Brothers, said to be the largest wholesalers of general merchandise in the United States announced on July 21 that drastic cuts in wholesale prices on more than 4000 merchandise items would go into effect that day. The new prices affect practically every line handled by the company. Reductions run from 2 to 60%.

The National Association of Manufacturers of Pressed and Blown Glassware met in Toronto on July 15 for wage conferences affecting fifteen branches of the industry in the United States and Canada. E. J. Barry is president, C. B. Roe, vice-president, John Kunzler, secretary and treasurer.

Corundite Refractories, Inc., Masillon, Ohio, has issued a revised 62-page catalog of corundite refractory products. These are illustrated and described with standard shapes shown, etc. About half of the catalog is devoted to general information about fire brick, tables of temperature, circumferences and areas of circles, weights of various materials, decimal tables, metric weights and measures, etc.

Owens-Illinois Glass Company directors voted on July 11 to declare a quarterly dividend of 75 cents on the common stock equivalent to $3.00 on an annual basis, compared with the $4.00 previously earned. The regular quarterly dividend of $1.50 on the preferred stock was also declared. It was reported that the volume of business done by the company the first half of this year compared favorably with the corresponding period in 1929. The reason given for reducing the dividend was the prevailing conditions in business and the company's desire to retain their strong current position.

Solvay Sales Corporation, New York, who market the alkalis and chemical products manufactured by the Solvay Process Company at plants situated in Syracuse, N. Y., Detroit, Mich., and Hutchinson, Kans., and who maintain offices in various large cities have issued the following information regarding their present sales organization: H. F. Merritt is director of sales in charge of the activities of the company; W. E. Blair, assistant director of sales; L. B. Gordon and H. O. Pierce, division sales manager; J. V. Stauf, manager of branch offices.

The Harshaw Chemical Company of Cleveland, O., is now occupying a new building at Philadelphia for warehouse and office purposes. This together with the alteration of existing buildings increases the warehouse facilities by more than 100%, giving a total of 39,000 sq. ft. for such purposes. Sales and branch office activities are located on the second floor. Alterations have provided space for the factory offices and the new laboratory which functions chiefly in plant control but carries on some experimental work as well.

The Monongah Glass Company, Fairmont, W. Va., recently put their big new tank, construction of which was recently finished, into operation on five bottle machines. The company's production has been remarkably increased during the past year or so. Operations were started with one bottle machine on tank number 3 in March. This was increased to five machines and recently seven machines have been in operation. Tank number 4 is now operating Hartford-Empire machines on tumblers. Twelve carloads of this ware are being shipped daily. This makes six carloads daily of raw material. L. B. Darbie, manager of the company, is celebrating his second anniversary with the company on August 1.

The Capstan Glass Company's new $250,000 unit, which has been constructed for them by The Austin Company, Cleveland, O., industrial engineers and builders, is about ready to be put into operation. The new unit is a one-story steel frame building 160 by 340 feet. About 150 tons of structural steel were used in its construction. The floors are of concrete and wood block. This new building, according to an announcement made by G. F. Rieman, president of the company at the time the building contract was awarded, will be occupied by the Fort Wayne Paper Company under a lease, for the manufacture of corrugated boxes. It was stated that the glass company will take 75% of the paper company's output.

The Magnolia Bottle Company, Bristow, Okla., in which C. P. Zeanor and his son C. P. Zeanor are interested and of which Brook Ramey is president and Hilton Burke, secretary, is negotiating with the Chamber of Commerce, Brownwood, Texas, a proposition to remove their plant from Bristow to Brownwood. According to report the Magnolia concern has a weekly payroll of between two thousand and twenty-five hundred dollars and employs between 65 and 75 workers throughout the year. Cheap gas and glass sand is available near Brownwood. It is reported locally that natural gas can be bought at 11 cents or less and that sand can be delivered to Brownwood from Santa Anna, twenty miles away, at about $2.00 per ton. The quality of the sand is not mentioned. It is stated that by moving to Brownswood the company could save between $150,000 and $200,000 per year. At present the Bristow plant has a capacity of about one and a half carloads of bottles per day.

John W. Patton Company of West Virginia has been incorporated with a capital of $100,000 to manufacture glass specialties including display counters, shelving, mirrors, windshields, automobile glass, etc. It is stated that the company will utilize at Clarksburg, W. Va., the waste cuttings from the Adamston Flat Glass Company and Pittsburgh Plate Glass Company's local plants. A number of experienced employes from the company's plant at Manorville, Pa., near Kittanning, Pa., will, it is stated, be brought to Clarksburg, but reports that the business would be moved to Clarksburg were denied. Mr. Patton is president of the new Clarksburg company and Major Devericks who was active in financing the company is treasurer. Osman E. Swartz of Charleston was made vice-president and E. M. Newton of Manorville was chosen secretary. West Virginia capital exclusively is said to be back of the enterprise. Machinery has been installed, manufacturing operations have begun in the building formerly occupied by the Auburn Motor Sales Company of West Pike Street. John A. Palko of Ottawa, Ill., has been employed as foreman. Most of the fifty or sixty workers who will eventually be employed will be recruited in Clarksburg.

Coming Meetings

The Eastern Division of the National Glass Distributers Association will hold its fall meeting at Atlantic City, September 3-5. The first meeting of the *Western Division* will be held at Chicago, September 10-12.

The Illuminating Engineering Society will hold its 24th annual convention at the Hotel John Marshall in Richmond, Va., October 7-10, 1930.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C.

South Africa—46379, Glass fruit jars.

Inquiries Received

For further information address THE GLASS INDUSTRY

513. Have the kindness to give me addresses of several manufacturers in the U. S. A. who produce reflex gauge glasses of the Klinger type.

514. We are in the market for quantities of lenses with facets for light refraction.

515. We want to get in contact with an American manufacturer of the so-called "Beetleware," a product described as being an unbreakable glass composition in all colors.

516. We are organizing a company for the purpose of making bottles, having a good local supply of glass sand and natural gas. Kindly put us in touch with manufacturers of bottle making machinery.

517.—We are looking about for a manufacturer who can supply a round glass window, convex on the outside surface and about ¾" diameter for use with an "on and off" indicating switch. The glass does not need to be of optical quality, just a good quality clear glass thick enough to resist breaking.

518.—Kindly have the manufacturers send to us full information on the fuel oil centrifuge described a short time ago in your paper.

Readers Wants and Offers

Copy Wanted of February 1930 Issue

The Norway Government Patent Office wants a good copy of the February, 1930 number of this journal and will pay a small premium to anyone who can accommodate them. Address, THE GLASS INDUSTRY, 24 West 40th Street, New York.

Current Prices of Glass-Making Materials

July 22, 1930

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.46	.46
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.35½
Alcohol, denatured	gal.	..	.52
Aluminum hydrate (Al $(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09⅜
Antimony oxide (Sb_2O_3)	lb.	..	.09⅜
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb.	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.80-1.00
Orange	lb.	..	.90-1.00
Yellow	lb.	..	1.40-1.65
Chromium oxide (Cr_2O_3)	lb.	.24	.24
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.23-.27
Black prepared	lb.	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.		.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	..	.07½-.07¾
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.0450
Black (FeO)	lb.	.04½	..
Kaolin (f.o.b. mine)	ton	9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.079	.09
Litharge (PbO)	lb.	.069	.08
Lime—			
Hydrated (Ca$(OH)_2$) (in paper sacks)	ton	10.50	..
Burnt (CaO) ground, in bulk	ton	7.00	..
Burnt, ground, in paper sacks	ton	9.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15-2.25	2.30-2.60
Limestone ($CaCO_3$)		2.00-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¼
Ground	lb.	.11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	24-.26
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.80-1.90
Silver nitrate ($AgNO_3$)	(100 oz.) per oz.	..	.25¾-.30¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.90-2.00
In bags	Per 100 lb.	1.37½-1.40	1.72½
Spot orders	.025 per 100 lbs. higher		
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04¼
95 per cent.	Per 100 lb.	1.99-2.10	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.39	.37½
Tin oxide (SnO_2) in bbls.	lb.	..	.36-.40
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to June 25, 1930

	May 1929 Quantity	May 1929 Value	May 1930 Quantity	May 1930 Value	Five Months Ending May 1929 Quantity	Five Months Ending May 1929 Value	Five Months Ending May 1930 Quantity	Five Months Ending May 1930 Value
Glass and glass products (Total)	.....	$897,663	.....	$893,707	.....	$4,570,499	.....	$4,024,640
Plate and window glass—								
Window glass, common, box 50 sq. ft.	2,045	2,366	1,769	12,425	9,540	50,108	8,195	46,026
Plate glass, unsilvered, sq. ft.	161,900	61,486	426,304	125,880	941,300	330,947	1,488,504	465,457
Other window and plate glass lbs.	298,445	32,627	442,373	39,350	2,001,630	206,832	2,260,310	211,373
Glass containers (bottles, vials and jars)	.....	268,279	.....	295,173	.....	1,386,300	.....	1,239,077
Table glassware, plain	.....	107,724	.....	109,704	.....	637,844	.....	548,767
Table and other glassware, cut or engraved	.....	13,886	.....	7,419	.....	52,859	.....	42,359
Lamp chimneys and lantern globes lbs.	132,419	24,527	116,338	22,232	670,625	140,550	497,175	96,406
Globes and shades for lighting fixtures lbs.	195,813	69,616	151,794	53,206	891,297	328,550	749,313	272,570
Chemical glassware lbs.	16,520	13,222	17,081	19,204	95,833	88,262	95,146	91,493
Electrical glassware, except for lighting lbs.	492,345	36,127	410,080	31,877	2,985,545	219,479	2,361,840	155,469
Other glassware	.....	200,803	.....	177,237	.....	1,128,768	.....	855,643

IMPORTS

Corrected to June 25, 1930

Glass and glass products	.....	1,190,833	.....	837,952	.....	5,342,644	.....	4,017,990
Cylinder, crown and sheet—								
Unpolished, not bent, obscured, beveled, etc.—								
Weighing less than 80 pounds per case dut. lb.	4,419,833	107,782	259,783	9,940	17,301,691	445,515	3,146,753	119,590
Weighing 80 pounds or over per case dut. lb.	3,082,884	121,905	1,446,038	61,438	14,254,435	522,336	6,953,604	275,230
Polished and bent, obscured, beveled, colored, etc., unpolished and polished, and all silvered dut.	.....	52,924	.....	38,629	.....	258,764	.....	175,289
Plate glass—								
Polished, unsilvered dut. sq. ft	870,544	164,803	340,003	64,995	4,681,240	1,016,913	2,548,304	530,771
Other dut. sq. ft.	110,443	17,228	80,530	21,441	593,227	110,552	323,239	118,512
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	17,083	.....	109,159	.....	111,667	.....	622,825
Table and kitchen utensils dut.	.....	18,612	.....	11,931	.....	96,133	.....	70,125
Glassware, cut or decorated dut.	.....	263,242	.....	138,102	.....	1,108,696	.....	726,964
Blown, glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	171,117	.....	192,099	.....	431,800	.....	320,793
Bulbs for electric lamps dut. No. 1	908,010	8,687	1,692,768	18,236	7,986,025	67,358	7,160,660	65,194
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	68,546	.....	38,943	.....	392,882	.....	285,516
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	53,690	.....	57,232	.....	230,384	.....	250,209
Other glassware dut.	.....	125,124	.....	75,807	.....	549,644	.....	456,972